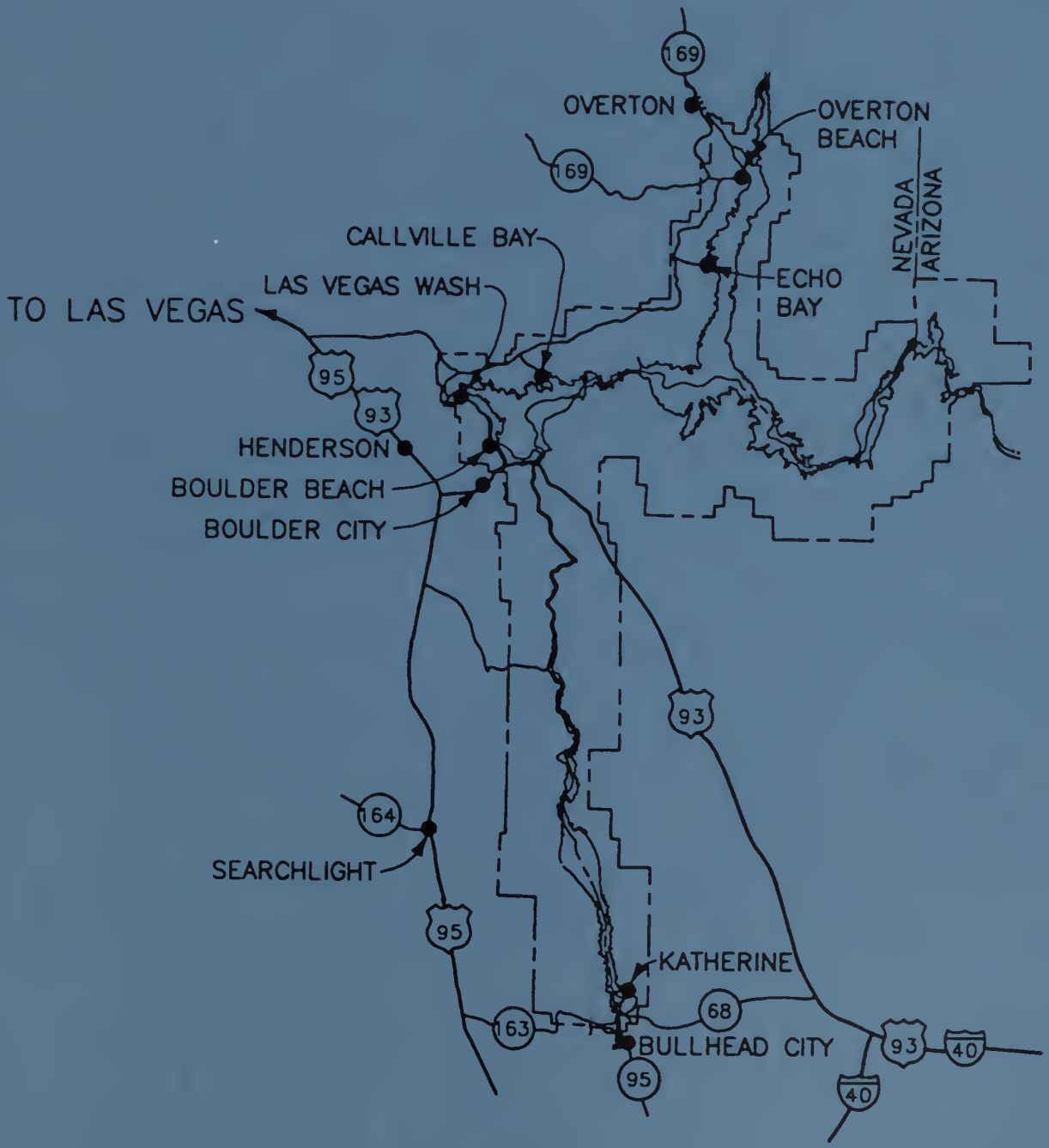
# SURFACE WATER TREATMENT RULE

# COMPLIANCE STUDY




**LAKE MEAD NATIONAL RECREATION AREA**
SURFACE WATER TREATMENT PLANTS

LAME

# SURFACE WATER TREATMENT RULE COMPLIANCE STUDY

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march, 1993

SURFACE WATER TREATMENT PLANTS
**LAKE MEAD NATIONAL RECREATION AREA**
**BOULDER CITY, NEVADA**

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UNITED STATES DEPARTMENT OF THE INTERIOR/NATIONAL PARK SERVICE
DENVER SERVICE CENTER - WESTERN TEAM

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# EXECUTIVE SUMMARY

## INTRODUCTION

The Surface Water Treatment Rule (SWTR) is a regulation resulting from the 1986 amendments to the Safe Drinking Water Act of 1974 that applies to all domestic water systems that are supplied by surface water and/or groundwater under the direct influence of surface water. The regulation states that all surface water used for potable water shall be filtered and disinfected to ensure compliance with water quality criteria related to biological contaminants.

The state of Nevada conducted a survey of all the Lake Mead National Recreation Area surface water treatment facilities. This survey concluded that numerous improvements would need to be made to the existing water treatment facilities to comply with the SWTR. Other alternatives to supply potable water to the public are developing groundwater supplies at each development, or connecting to an outside water utility. Potable water from wells (assuming no direct surface water influence) would not be regulated by the SWTR. Connecting to an outside water utility would not require the park to comply with any regulations pertaining to source protection or treatment, but the utility company supplying the water would be required to comply.

## PROBLEMS

The state of Nevada found from their survey of the surface water treatment facilities at Lake Mead that the existing treatment facilities need an operations plan, improvements in the chemical addition/coagulation/flocculation/sedimentation processes, and optimization of backwash procedures. A more detailed outline of the deficiencies is presented in the body of this report.

## RECOMMENDATIONS

Table 1 illustrates the cost comparison of the alternatives that were studied for each development. The present worth values shown in the table include gross construction costs, design costs and operation and maintenance costs. Conversion to a groundwater source is preferred in each area, based on the information in hand and

the analysis presented herein. A program of exploration and testing for groundwater suitability is recommended to verify assumptions used in determining viability and costs.

At Katherine, the present worth costs estimated for the alternative of purchase and operation of the water system by Citizens Utilities are close enough to those estimated for groundwater development to merit further consideration. When criteria beyond the realms of engineering and economics are considered, this option may be preferable. Furthermore, verbal indications of interest by Citizens Utilities in similar proposals for other developments within Lake Mead NRA could warrant more formal pursuit. However, with the available information, it appears that this option is more viable at Katherine than the other five areas studied.

**TABLE 1**

| DEVELOPED AREA AT LAKE MEAD | ALTERNATIVES[4] PRESENT WORTH VALUES | | |
|---|---|---|---|
| | UPGRADE TREATMENT FACILITIES | DEVELOP GROUNDWATER SOURCE | CONNECT TO OUTSIDE UTILITY |
| BOULDER BEACH | $ 1,500,000[1]<br>$ 1,800,000[2] | $ 1,000,000[3] | $ 3,400,000 |
| CALLVILLE BAY | $ 1,300,000[1]<br>$ 2,000,000[2] | $ 1,000,000[3] | N/A |
| ECHO BAY | $ 1,800,000[1]<br>$ 3,000,000[2] | $ 1,000,000[3] | N/A |
| LAS VEGAS WASH | $ 1,400,000[1]<br>$ 1,900,000[2] | $ 1,000,000[3] | $ 1,900,000 |
| OVERTON BEACH | $ 1,600,000[1]<br>$ 1,700,000[2] | $ 1,000,000[3] | N/A |
| KATHERINE | $ 1,600,000[1]<br>$ 2,100,000[2] | $ 1,000,000[3] | $ 1,200,000[5] |

NOTES:

[1]Present Worth value for the SWTR improvements only.

[2]Present Worth value for SWTR compliance plus additional recommended improvements.

[3]Preferred alternative for the developed area.

[4]These Present Worth values are for the purpose of cost comparison of alternatives and should not be used for budgeting. These present worth values do not include the cost of water, since the value would be the same for each alternative.

[5]This alternative for Katherine includes a credit for the present worth value for the purchase of the existing water treatment plant, storage and distribution system by Citizens Utilities.

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# SURFACE WATER TREATMENT RULE COMPLIANCE STUDY

## BACKGROUND

The 1986 Amendments to the Safe Drinking Water Act required the US Environmental Protection Agency and the states to develop and implement new drinking water regulations. The regulations address specific water quality constituents which must be monitored as well as procedures for treating potable water. One of these regulations is 40 CFR Part 141 Subpart H, known as the Surface Water Treatment Rule (SWTR). The SWTR applies to all public water systems using surface water and groundwater under the influence of surface water. It stipulates two things; first, all surface waters must be disinfected; second, all surface waters must be filtered unless certain stringent source water quality requirements, disinfection, monitoring in lieu of treatment, and site-specific conditions are met. Final compliance for the SWTR regulation must not be later than June 29, 1993.

The EPA published a national version of each regulation in the Federal Register. Next each state reviewed the federal regulation and adopted their own criteria. In all cases the state version had to be at least as restrictive as the federal version.

The combination of the two treatment barriers, filtration and disinfection, are to achieve a minimum 3-log (99.9%) removal/inactivation of Giardia cysts and a 4-log (99.99%) removal/inactivation of viruses. Of the approved filtration processes described in the SWTR compliance manual published by EPA, all six of the plants analyzed in this study are of such a configuration and are presently operated in such a manner as to most closely resemble "direct filtration". Direct filtration is given credit for a 2-log (99%) removal/inactivation of Giardia cysts and a 1-log (90%) removal/inactivation of viruses. The EPA recommends that direct filtration systems provide sufficient disinfection to achieve a minimum of 1-log Giardia cyst and 3-log virus inactivation.

On March 4 and 5, 1991, the state of Nevada Department of Human Resources and a USEPA Environmental Engineer conducted sanitary inspections at the following

Lake Mead developments: Echo Bay, Callville Bay, Overton Beach, Las Vegas Wash, and Boulder Beach (see site plan, figure 1). These inspections found that several improvements must be completed for the domestic water systems in these areas to comply with the Nevada Surface Water Treatment Rule. The findings from these inspections generally include the need for development of an operations plan for each facility, improvements in or addition of the chemical addition/coagulation, and flocculation/sedimentation processes, and optimization of backwash procedures.

Upon receiving this data from the state of Nevada, the National Park Service undertook a review and study of all surface water treatment facilities in the park. Katherine Landing, which has the park's only other surface water treatment facility at Lake Mohave, and is in Mohave County in the state of Arizona, was also included.

This study includes an evaluation of each of the water treatment plant facilities, and an analysis of alternatives for SWTR compliance. Conclusions from this analysis and recommendations are presented in section V.

## LAKE MEAD NATIONAL RECREATION AREA
SURFACE WATER TREATMENT PLANTS

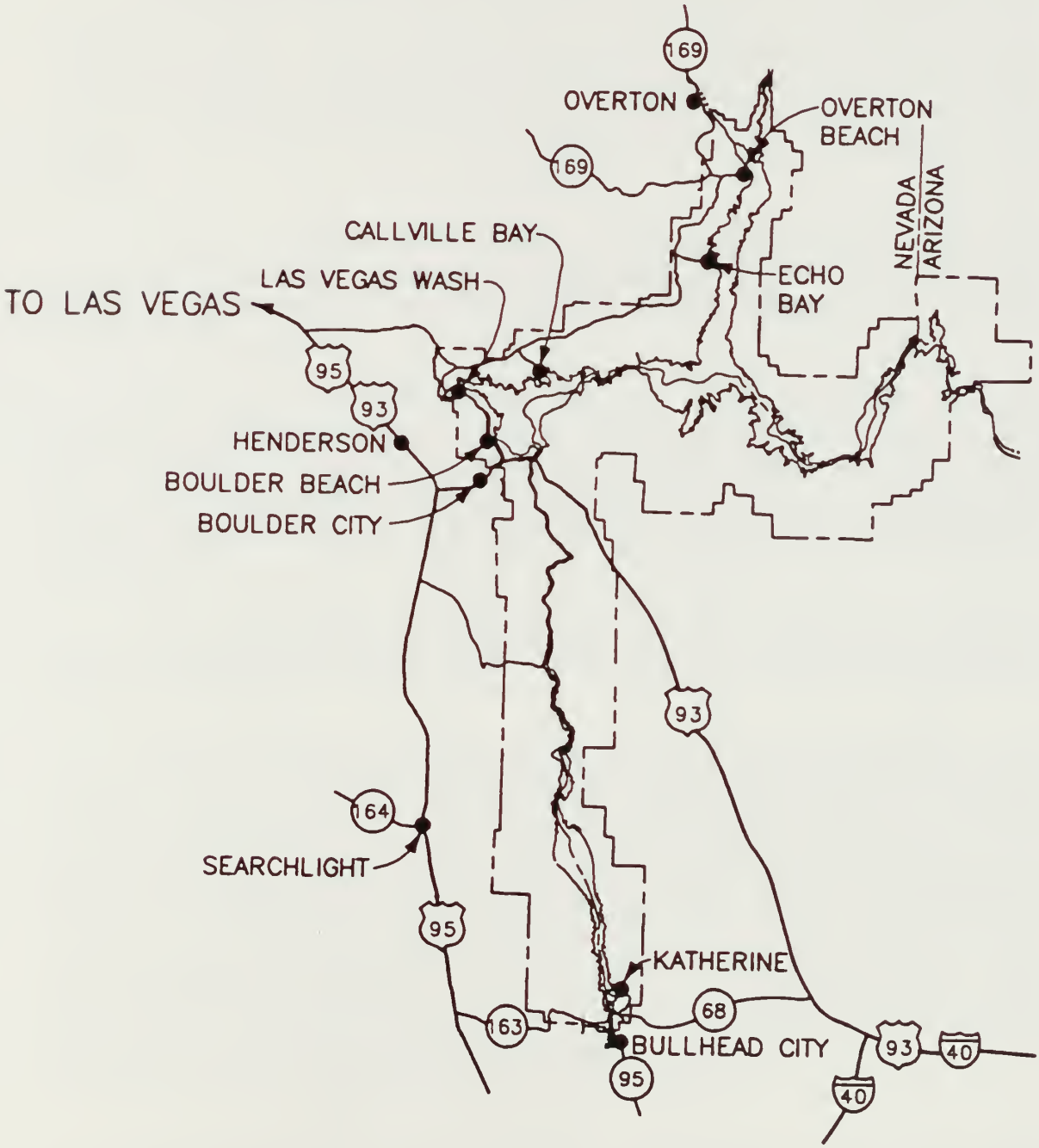


**FIGURE 1** SITE PLAN

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## I. GENERAL SWTR COMPLIANCE DEFICIENCIES AT LAKE MEAD

Nevada State Health Division personnel (referring to the regulation from Nevada LCB File No. R067-90) discovered several violations of the SWTR at five Lake Mead surface water treatment plants. The five developments that were cited are Boulder Beach, Callville Bay, Echo Bay, Las Vegas Wash, and Overton Beach. A sixth development Katherine, as previously stated, is included because it is a surface water treatment plant and eventually it will be required to comply with the SWTR.

The first compliance deficiency cited relates to bypassing or lack of existing coagulation/flocculation facilities and use of a polymer as a filter aid. There is no testing being conducted to optimize polymer dosage rates, and in most cases mixing is inadequate.

This aspect of SWTR compliance can be accomplished by using coagulation/flocculation units, existing or new construction, at all times when a plant is operating. Mixing may be accomplished by the use of an inline static mixer. (As a "direct filtration" facility, ferric chloride or alum have to be used as the primary coagulant in addition to the polymer as a filter aid. See the discussion of direct filtration on pg. 41).

The effectiveness and optimization of these processes must be demonstrated by jar testing, pilot filter column testing or other means acceptable to the health division.

The next deficiency cited was with monitoring turbidity and disinfection. The Nevada State Health Division requires that turbidity and disinfection be monitored and that a monitoring "plan" be in place. Either daily grab samples of raw water must be collected and analyzed, or continuous turbidity measurements may be used in lieu of grab sampling if the accuracy of the measurement is validated each week. For combined filter effluent, the level of turbidity must be determined from each filter by samples taken before clearwell storage at least once every four hours that the system is in operation. The concentration of residual disinfectant in the water being delivered to the distribution system must be continuously measured and recorded. The concentration of residual disinfectant must not fall below 0.2 milligrams per liter at all points in the distribution system.

A monitoring plan and CT (the product of disinfectant concentration and its contact time) determinations can be done by measuring and recording the

parameters needed, which are:

1. The temperature of the disinfected water.
2. The pH of the disinfected water.
3. The disinfectant contact time, measured during peak hourly flow.
4. The concentration of the residual disinfectant before or at the point the water reaches the first customer (or domestic tap).
5. Verification of plug-flow conditions can be done by tracer study.

The measurement of the concentration of the residual disinfectant must be taken at the same frequency, time and location as the total coliforms measurement.

The state regulations require that 90 percent of the turbidity measurements following backwashing procedures or interruption events be less than 1.0 NTU, and less than 0.5 NTU within four hours. A sampling tap must be available for each filter and a monitoring plan developed for the turbidity of water from individual filters following backwashing procedures in order to assess compliance with these requirements. If these requirements can not be met, it is presumed that backwash procedures are not adequate. In this case, higher backwash rates, installation of surface wash provisions or other improvements may be necessary.

After backwashing procedures or other interruptions of filtration, facilities must "filter to waste" (waste product water until turbidity clears up) prior to supplying water into the distribution system. This will necessitate either expanding the backwash waste lagoons, or discharging to a sewage facility or other permitted discharge location.

Another deficiency common to the facilities of all the developments is the lack of adequate flow metering capabilities. The state regulations state that a plant operating in the direct filtration mode must operate at a rate of flow not to exceed 3 gpm/sf for a single media filter and 6 gpm/sf for deep bed, dual or mixed media filters under conditions of gravity flow. Pressure filters must operate at a rate of filtration that do not exceed 2 gpm/sf for a single media filter or 3 gpm/sf for dual, mixed media or deep bed filters.

The water treatment developments at Lake Mead are also not in compliance with provisions of the SWTR relating to requirements of suppliers of water. The Nevada regulations state that a supplier of water must ensure that the persons who operate the facility for treatment have received:

1. A certificate of competency in water treatment operations issued by

the Association of Boards of Certification, P.O. Box 786, Ames Iowa 50010-0786; or

2. A certificate of competency issued by the American Water Works Association, California-Nevada Section, P.O. Box 5429, San Bernardino, California 92412.

The SWTR further requires that each water treatment plant have an approved "operations plan". The facilities addressed in this study do not have approved plans. The plan must be designed to produce the optimal quality of water from the treatment process and must be submitted to the health division for review and approval. The supplier must operate the facility in accordance with the approved plan. The plan must include a description of:

1. The program for monitoring the performance of the treatment plant;
2. The program for maintaining unit process equipment;
3. The persons who operate the facility, including the number of staff and the level of their training;
4. The operation of each unit process;
5. The procedures used in the laboratory, if applicable;
6. The procedures used to determine chemical dose rates;
7. The records of the facility;
8. The procedure for responding to an emergency at the plant or involving the watershed; and
9. Any other features that contribute to the reliable operation of the plant.

## II. INDIVIDUAL FACILITIES AND SPECIFIC SWTR DEFICIENCIES

### BOULDER BEACH

#### EXISTING CONDITIONS

Boulder Beach is located on the western shoreline of Lake Mead, approximately 3 miles from Boulder City and 20 miles from Las Vegas. The area is easily accessed from US 93 by Lakeshore Drive. The terrain gradually slopes to the lake with vegetation that consists of brush, sage and transplanted trees. Boulder Beach is one of the most popular day use areas in the NPS. According to park records, annual average visitation is estimated at 11,400 people per day. Facilities maintained by the NPS at Boulder Beach include Lake Mead Marina, Boulder Beach, Hemenway Beach, and the Allen Bible Visitor Center. Boulder Beach is a 10-acre mixed activities beach with a swim beach, store, Lakeshore Trailer Village, and Lake Mead Lodge. The park is open year around with water sports favored during warmer months and fishing favored during colder months.

The raw water serving Boulder Beach is obtained from Lake Mead at Pyramid Island. This island is located near the marina and is accessible by foot during low water levels. The water is pumped from the Lake Mead intake structure, located at Pyramid Island, through a pipe under the marina causeway to the water treatment plant. The intake structure consists of three 12-inch incline wells, a valve box and three submersible 1,050 gpm pumps.

The existing 1.5 million gallons per day (mgd) direct filtration plant was constructed in 1968. The raw water quality is excellent. The average influent turbidity is 0.88 NTU, and semi-monthly coliform tests are generally negative. Coliform samples are taken from a raw water tap at the treatment plant. The raw water initially is clarified in a 35-foot diameter tank that was originally used as a flocculator. Following the clarifier tank, polymer is added (to enhance solids capture) to the raw water before filtration by four manually operated rapid-sand filters that remove suspended solids with 30 inches of stratified sand, anthracite coal and gravel. Each filter is 10.5-foot in diameter, providing a surface area of 87 square feet, and a filter rate of 3.0 gpm/sf. Bypass piping permits the raw water to flow directly to the filters, if necessary (see figures 2, 3, 4, 5, 6, and 7). Chlorine solution is injected upstream of the 23,000 gallon clearwell (downstream of the filters). The chlorine contact time of 4.7 hours or more in the storage tanks. The treated water from the clearwell is pumped to above ground storage tanks for distribution. The minimum CT value is computed to be 34, with conditions of a

residual chlorine concentration of .6 mg/l, water temperature of 20 degree celsius, and pH of 7.5. The computed CT value is more than the minimum allowable CT value of 1.

Boulder Beach has a total of 2.5 million gallons available storage capacity for treated water. The current storage capacity is from two aboveground welded steel tanks with volumes of 0.25 and 2.0 million gallons. The rest of the available storage capacity is from an underground concrete 0.375 million gallon tank that is not currently in use due to the lack of demand and the need for possible cleaning and repair of the tank interior. These storage tanks are located just west of the campgrounds and trailer village. Hydraulic detention times at average and design flows are 5.8 and 1.8 hours, respectively.

The average and peak monthly water demands are estimated at 450,000 and 748,700 gpd which can easily be met by existing facilities.

## SWTR DEFICIENCIES

The state of Nevada stated that the Boulder Beach treatment facilities will need the following improvements to comply with the SWTR:

- provisions for utilizing ferric chloride or alum as the primary coagulant
- refurbishing and reactivating the flocculator
- providing an adequate monitoring plan and sampling equipment for disinfection, flow, and turbidity
- discharging waste from backwashing to a lagoon, sewage facility, or permitted discharge location
- provide additional certification and training for operators and back-up operators (Grade II license required for treatment and distribution)
- provide an approved operations plan
- provide an adequate ventilation/exhaust system for the compressed chlorine gas cylinders
- provide an emergency chlorine repair kit.
- provide filter-to-waste provisions
- provide surface wash or air scour for backwashing efficiency

Most of the required improvements were described in the previous section. Design and construction costs for the improvements were estimated and used as a basis for comparison with other alternatives for SWTR compliance. This comparison is presented in Section V.

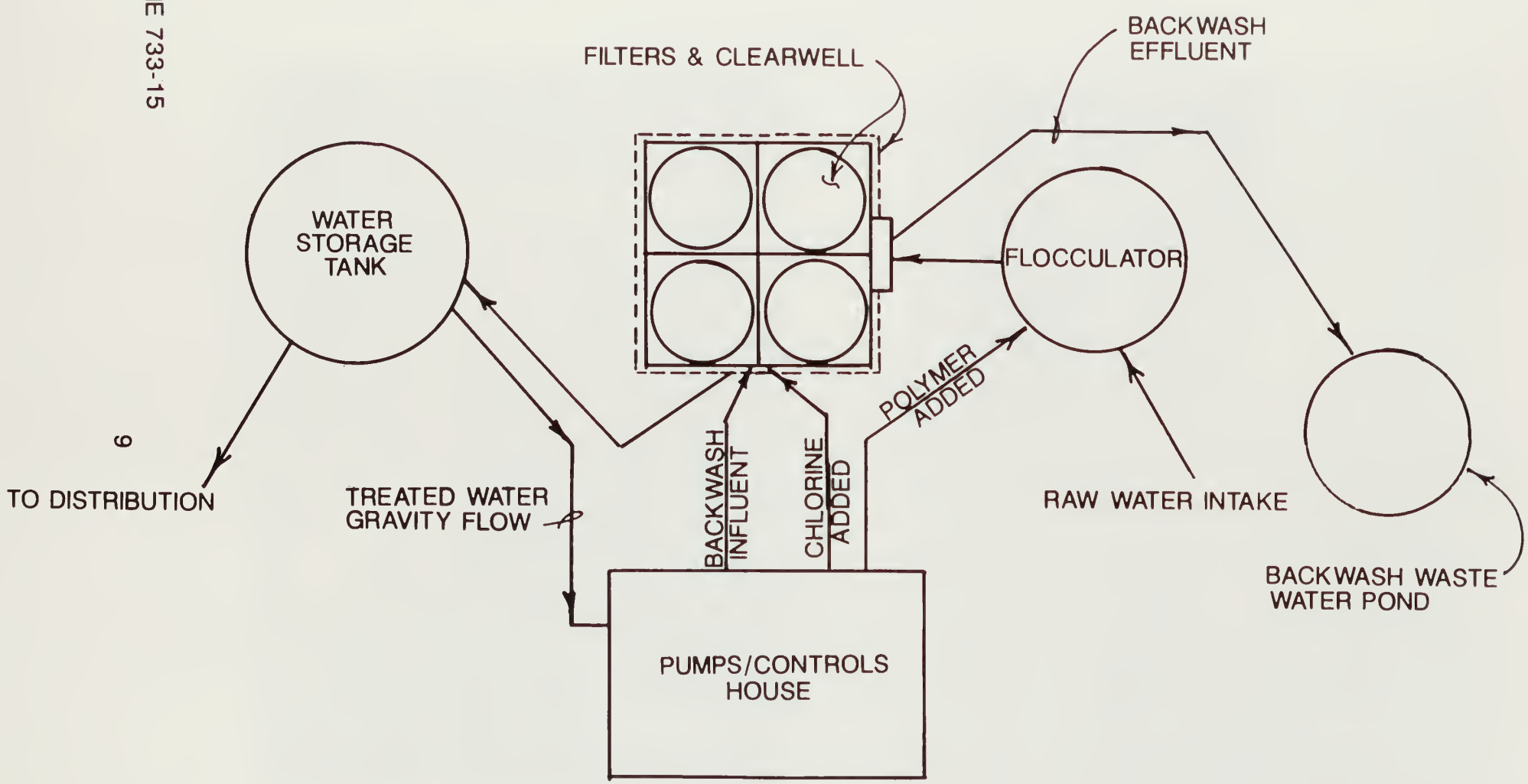


**FIGURE 2** FLOW DIAGRAM FOR THE BOULDER BEACH WATER TREATMENT PLANT

**Figure 3 - BOULDER BEACH WATER TREATMENT PLANT**
The storage tank, filters and clarifier are to the right of the pump house.

**Figure 4 - BOULDER BEACH WATER TREATMENT PLANT**
Filters, piping, and appurtenances.

**Figure 5 - BOULDER BEACH WATER TREATMENT PLANT**
Filters with valves, platform and storage tank in the background.

**Figure 6 - BOULDER BEACH WATER TREATMENT PLANT**
Southern entrance to the pump house.

**Figure 7 - BOULDER BEACH WATER TREATMENT PLANT**
Backwash waste water pond in need of cleaning.

## CALLVILLE BAY

### EXISTING CONDITIONS

Callville Bay is located 27 miles north of Boulder Beach and 28 miles east of Las Vegas. Development at Callville Bay has been restricted due to the steep topography. Lake Mead landforms provide a natural harbor at Callville Bay that attracts visitors to the development for boating and fishing. The average visitation on an annual basis is estimated at 1,200 people per day.

Raw water is pumped from Lake Mead by two vertical turbine 300 gpm pumps and a 6-inch cast iron pipe to a 0.3 million gallon raw water storage tank. Minimal maintenance has been performed on the intake pumps since their installation 20 years ago. The intake structure is constructed of a galvanized steel platform and pontoons. The intake structure deck and pontoons have rusted and the pipeline floats have deteriorated.

The potable water is treated by a 200 gpm direct filtration water treatment plant. The average influent turbidity is 0.55 NTU. The influent coliform count has been less than 10 organisms per 100 ml for semi-monthly samples. From the raw water storage tank, located adjacent to the treated water storage tank, water flows by gravity to irrigation or to treatment for potable water. The raw water bypasses the existing 18.5-foot diameter flocculator basin and goes directly to filtration. Polymer is added prior to the 11.5-foot diameter dual-media gravity sand filter. The filter rate is 2 gpm/sf. No pressure differential gauges are available to determine head loss, thus backwashing is not optimized. Chlorine solution is added prior to entering the 32,000-gallon clearwell. Chlorine contact time is 2.6 hours. The computed CT value is 7.5 with conditions of a residual chlorine concentration of 0.6 mg/l, water temperature of 20 degree celsuis, and Ph of 7.5. The computed CT value is more than the minimum allowable CT value of 1. The treated water is pumped from the clearwell to the treated water storage tank (see figures 8, 9, 10, and 11). The average effluent turbidity is 0.14 NTU.

Storage capacity for treated water is 100,000 gallons and for raw water is 300,000 gallons. Detention time for average and peak flows are 9 and 2.5 hours. The raw water storage is used for irrigation and fire protection demand. The irrigation and fire system water is distributed throughout the area by a separate non-potable water pipeline. Callville Bay is one of two Lake Mead sites that has separate systems for potable and non-potable water.

Domestic water usage is estimated at 38 percent of the total withdrawal

based on water records. The remaining 62 percent of raw water is used for either irrigation or fire protection. Monthly average and peak use of domestic water is approximately 80,000 gpd and 125,000 gpd, respectively.

## SWTR DEFICIENCIES

The state of Nevada stated that the Callville Bay water treatment facility will need the following improvements to come into compliance with the SWTR. These include:

- provisions for utilizing ferric chloride or alum as the primary coagulant
- refurbishing and reactivating the flocculator
- providing a monitoring plan and sampling equipment for turbidity, flow and disinfection
- improvements to the existing backwash waste pond to prevent overflow, or improvements to allow discharge to the new waste water disposal lagoons
- providing additional certification and training for the operators and back-up operators (Grade II license required for treatment and distribution)
- providing an approved operations plan
- provide an adequate ventilation/exhaust system for the compressed gas cylinders
- provide an emergency chlorine repair kit
- construct an additional filter (redundancy for filtration is required)
- provide filter-to-waste provisions
- provide surface wash or air scour for backwashing efficiency

A discussion of these requirements was included in the previous section. Design and construction costs for these improvements were estimated and used as a basis for comparison with other alternatives for SWTR compliance. This comparison is presented in Section V.

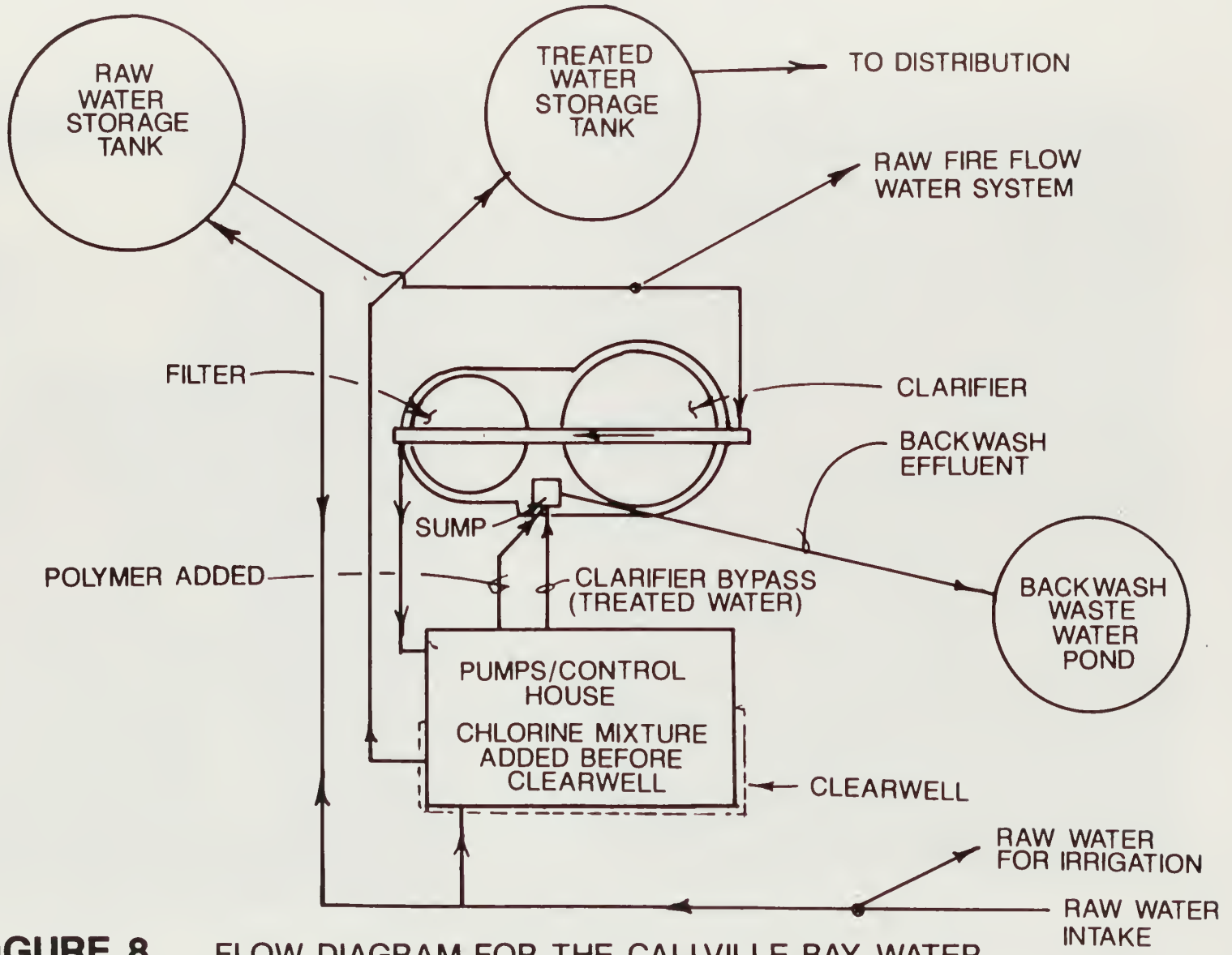


**FIGURE 8** FLOW DIAGRAM FOR THE CALLVILLE BAY WATER TREATMENT PLANT

**Figure 9 - CALLVILLE BAY WATER TREATMENT PLANT**
Pump house located over the clearwell.

**Figure 10 - CALLVILLE BAY WATER TREATMENT PLANT**
Water storage tanks on top of hill overlooking the clarifier.

**Figure 11 - CALLVILLE BAY WATER TREATMENT PLANT**
Backwash waste water pond.

## ECHO BAY

### EXISTING CONDITIONS

Echo Bay is located on the Overton arm of Lake Mead, 47 miles north of Boulder Beach. Echo Bay is situated on a high bluff with a spectacular view of Lake Mead. The annual average visitation is estimated at 848 people per day due to the relative remoteness from any metropolitan area. Echo Bay provides both overnight and day-use accommodations.

Raw water is obtained from Lake Mead. The raw water is pumped by end suction centrifugal 225 gpm pumps, with a current pumping rate of 150 gpm. These pumps are located on a floating barge in Lake Mead. The barge deck and floats have rusted and minimal maintenance has been done on the intake barge.

The raw water is pumped, by pipeline, to a 225 gpm water treatment facility. The water treatment facility, constructed in 1967, has a current operating capacity of 145 gpm. The average influent turbidity is 0.54 NTU. Polymer is added to the raw water prior to clarification in a 20-foot diameter flocculator/clarifier basin. The water is filtered by a single automatic valveless gravity filter and then flows into the clearwell. This filter was designed for a flow of 340 gpm. This unit has become increasingly difficult to operate and has had several filter media breakthrough problems. The backwash waste water from the filters drains to an adjacent wash (see figures 12, 13, 14, 15, and 16). Disinfection is accomplished with a chlorine solution injected upstream of the 21,000-gallon clearwell, where chlorine contact time of 2 hours is provided. The computed CT value is 4.7 with conditions of a residual chlorine concentration of 0.6 mg/l, water temperature of 20 degree celsius, and pH of 7.5. The computed CT value is more than the minimum allowable CT value of 1. The detention time of 4.6 and 2.1 hours are for average and peak flows. The average effluent turbidity is 0.24 NTU.

There are two 200 gpm pumps located in a building adjacent to the filter. These pumps lift the treated water from the clearwell to two aboveground steel tanks. The aboveground storage tanks have capacities of 100,000 and 500,000 gallons. The monthly average and peak demand are 147,400 and 255,000 gpd. The present volume of storage is sufficient for anticipated future water storage requirements which include 169,500 gpd for domestic use and 120,000 gallons for a 2-hour fire flow of 1,000 gpm.

A hydropnuematic tank, located near the two aboveground storage tanks, provides water to areas that do not receive service from the gravity flow system.

## SWTR DEFICIENCIES

The state of Nevada stated that the Echo Bay water treatment facility will need the following improvements to comply with the SWTR:

- provisions for use of ferric chloride or alum as a primary coagulant
- provide a monitoring plan and sampling equipment for turbidity, flow and disinfection
- improvements to the existing backwash waste water disposal location to prevent overflow, or to allow discharge to go to a new waste water disposal lagoon.
- provide additional training and certification for the operator and back-up operator (Grade II license required for treatment and distribution)
- provide an approved operations plan
- provide an adequate ventilation/exhaust system for the compressed chlorine gas cylinders
- provide an emergency chlorine repair kit.
- construct an additional filter (redundancy for filtration is required).
- provide filter-to-waste provisions
- provide surface wash or air scour for backwashing efficiency

A discussion of these required improvements were described in the previous section. Design and construction costs for the improvements were estimated and used as a basis for comparison with other alternatives for SWTR compliance. This comparison is presented in Section V.

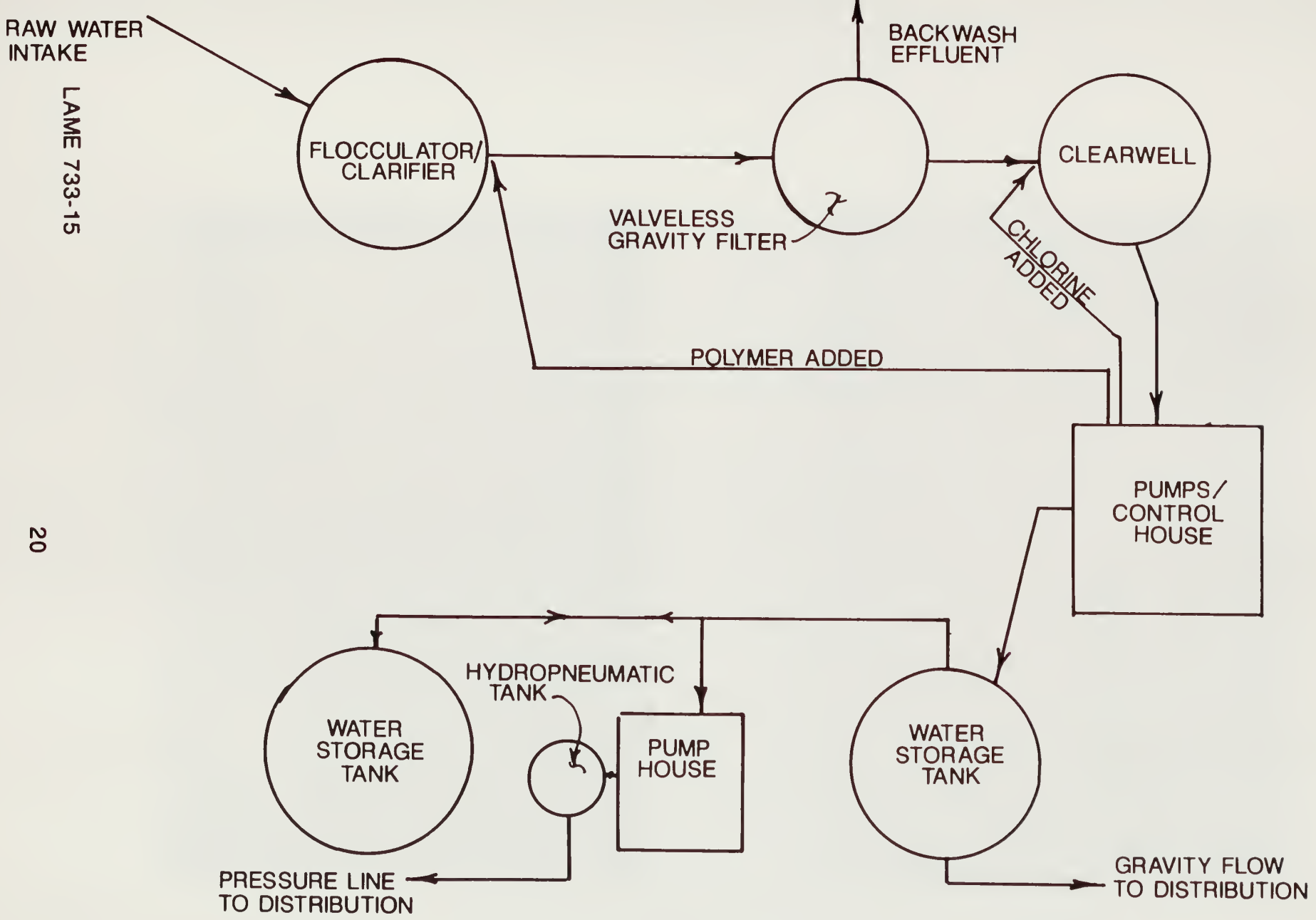


**FIGURE 12** FLOW DIAGRAM FOR THE ECHO BAY WATER TREATMENT PLANT

**Figure 13 - ECHO BAY WATER TREATMENT PLANT** Overall plant site. Notice the lush vegetation growth below the backwash waste water discharge location. Echo Bay does not have a backwash pond.

**Figure 14 - ECHO BAY WATER TREATMENT PLANT** Southwest view of the clarifier.

**Figure 15 - ECHO BAY WATER TREATMENT PLANT** Gravity flow filter left of the clearwell.

**Figure 16 - ECHO BAY WATER TREATMENT PLANT** Top view of the gravity flow filter. At the bottom of the filter notice the filter media.

## LAS VEGAS WASH

### EXISTING CONDITIONS

Las Vegas Wash is located 7 miles north of Boulder Beach where Las Vegas Wash flows into Lake Mead. Access to the treatment plant is from Lakeshore Road. The development is popular for day use because of its close proximity to the Las Vegas metropolitan area. The annual average visitation is 6,320 people per day. The area is very popular during the summer with water skiers, hot-boaters, and fisherman.

Raw water is obtained from Lake Mead and is transported by a 40-inch pipe owned by Basic Metals Incorporated (BMI). The intake and water line were constructed to serve the industrial complex in Henderson, Nevada. The BMI pipeline alignment goes west under Lakeshore Drive and alongside the NPS Las Vegas Wash Water Plant. The NPS connection for the water treatment plant is located southeast of the plant. A pressure reducing valve reduces line pressure from 320 psi to 60 psi. The park service has obtained water from the pipeline since 1940.

The raw water is processed through two Walker pressure filters, which were installed in 1984. The average influent turbidity is 0.83 NTU. The water flows directly to the two pressure filters with a total capacity of 120 gpm. There are no provisions for flocculation or clarification. Polymer is added upstream of the filters. Disinfection is accomplished by adding a chlorine solution upstream of the 100,000 gallon aboveground storage tank (see figures 17, 18, and 19). Chlorine contact time of 3.4 hours is provided by the water storage tank. The computed CT value is 1.9 with conditions of a residual chlorine concentration of 0.6 mg/l, water temperature of 20 degree celsius, and pH of 7.5. The computed CT value is more than the minimum allowable CT value of 1. The average effluent turbidity is 0.35 NTU.

The current storage tank of 100,000 gallons capacity is not sufficient for the average domestic and fire flow demands. Presently, the typical detention time is 18 hours. The future average and peak monthly water demand is predicted to be 90,000 and 147,700 gpd. Minimum active storage requirements for a 2-hour fire flow at 1,000 gpm is 120,000 gallons. Therefore, the required future water storage for average domestic demand plus 2-hour fire flow demand is estimated to be 210,000 gallons. An additional 110,000 gallons of storage capacity is needed.

## SWTR DEFICIENCIES

The state of Nevada stated that the Las Vegas Wash water treatment facility will need the following improvements to comply with the SWTR:

- provisions for utilizing ferric chloride or alum as a primary coagulant
- install a static mixer
- construct a flocculator/clarification facilities
- provide an adequate monitoring plan and sampling equipment for turbidity, flow and disinfection
- provide an adequate disposal site for backwashing waste water, such as a sufficiently sized lagoon, discharging to the existing sewage facilities, or a permitted discharge location
- provide additional certification and training for the operator and back-up operator (Grade II license required for treatment and distribution)
- provide an approved operations plan
- provide an adequate ventilation/exhaust system for the compressed chlorine gas
- provide an emergency chlorine repair kit
- perform annual inspection of the pressure filters
- provide filter-to-waste provisions
- provide surface wash or air scour for backwashing efficiency

A discussion of these required improvements is provided in the previous section, except for the last item.

An additional improvement that is required for the Las Vegas Wash facility is the pressure filter inspections. At a minimum, an annual inspection of the pressure filters is required to assure that backwashing procedures are adequately cleaning the filter media. This inspection should evaluate the condition of the media, formation of mudballs and short circuiting. A written record of the inspection must be maintained at the treatment plant.

Design and construction costs for these improvements were estimated and used as a basis for comparison with other alternatives for SWTR compliance. This comparison is presented in section V.

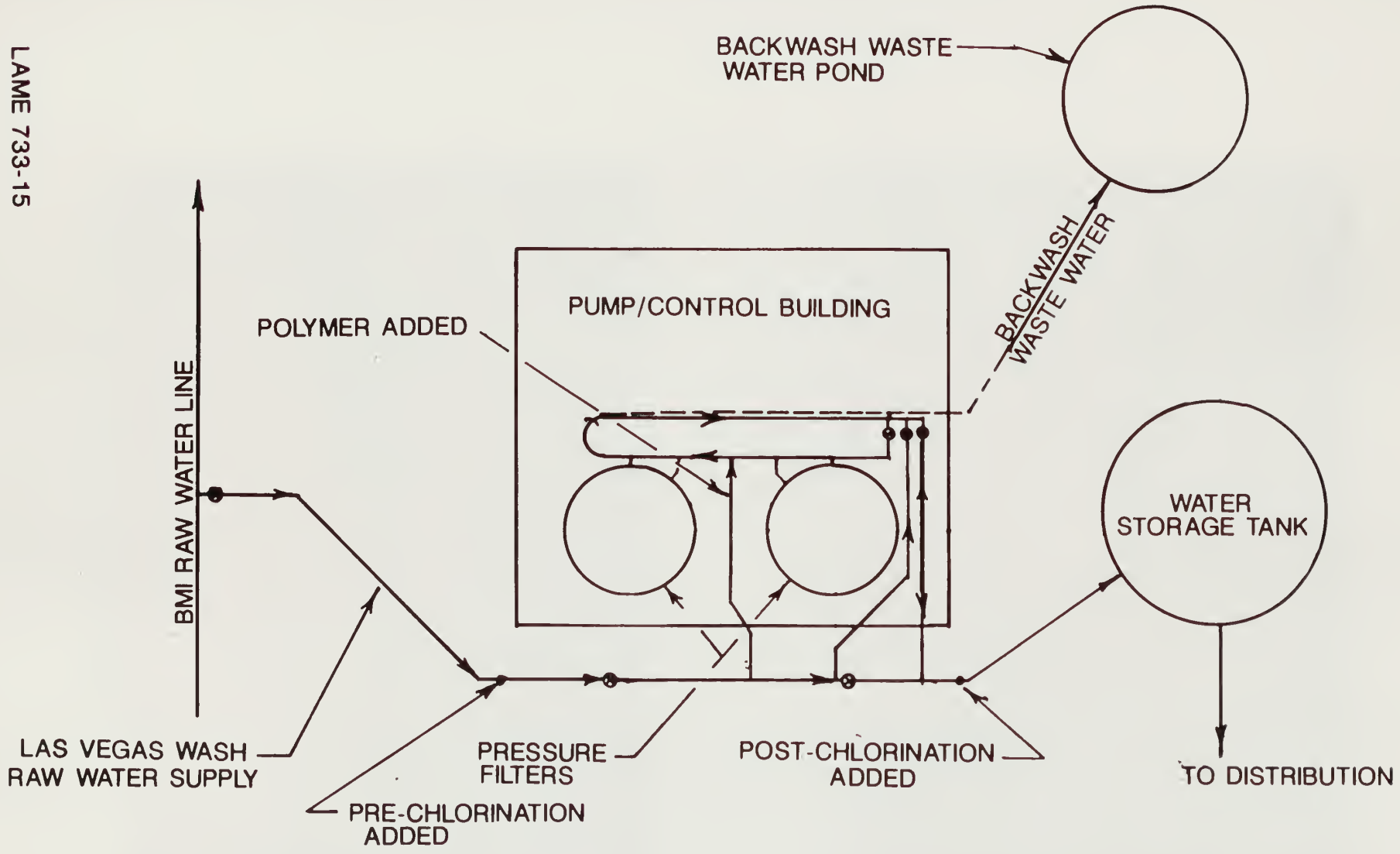


**FIGURE 17** FLOW DIAGRAM FOR THE LAS VEGAS WASH WATER TREATMENT PLANT

**Figure 18 - LAS VEGAS WASH WATER TREATMENT PLANT**
Pump house to the left of the water storage tank. The pressure filters are also in the pump house.

**Figure 19 - LAS VEGAS WASH WATER TREATMENT PLANT**
Backwash waste water pond in need of cleaning.

## OVERTON BEACH

### EXISTING CONDITIONS

This development is one of the most remote, least visited on Lake Mead. Overton Beach, located near the mouth of the Virgin River, is about 12 miles south of the town of Overton. Typical use of the Overton Beach area during the fall, winter, and spring is by fisherman. Pleasure boaters are the primary visitors during the summer. The annual average visitation is 673 people per day.

Raw water is obtained from Lake Mead by two submersible pumps, rated at 100 gpm. The raw water intake pumps are located on a submerge barge 1,500 feet offshore. Preventive maintenance has been minimal on the intake barge. Raw water quality data indicates seasonally high turbidity levels. Park personnel vary polymer dosages to respond to the varying turbidity levels. The dosages may be influenced by nutrient additions by the Nevada Division of Fish and Wildlife to enhance fish growth in the Overton area of Lake Mead.

Raw water is treated by a "package" water treatment plant, constructed in 1983, which was designed for 150 gpm. The raw water is pumped to and settled in two 2,500-gallon flocculation tanks and a polymer is added. Particles are then precipitated in a 3,500-gallon clarifier with tube settlers. From there the filtration is accomplished with two 37.5 square foot dual media filters, rated at 2 gpm/sf. A chlorine solution is injected upstream of the 10,000 gallon clearwell, the filtered water flows to the clearwell. The clearwell, along with the length of pipeline, provides a chlorine contact time of 2.5 hours. The treated water is then pumped to a water storage tank (see figures 20, 21, 22, and 23). The computed CT value is 20.5 with conditions of a residual chlorine concentration of 0.6 mg/l, water temperature of 20 degree celsius, and pH of 7.5. The computed CT value is more than the minimum allowable CT value of 1. The average effluent turbidity is 0.28 NTU.

The treated water is stored in a 300,000 gallon aboveground steel storage tank. The detention times are 6 and 1.7 hours for average and peak flows. Projected future average and peak monthly water demands are 17,250 and 58,500 gpd. Required storage for a 2-hour fire flow at 1,000 gpm is 120,000 gallons. Therefore, the total required storage capacity is 137,250 gallons. The existing water storage capacity of 300,000 gallons is more than sufficient.

## SWTR DEFICIENCIES

The state of Nevada stated that the Overton Beach water treatment facility will need the following improvements to comply with the SWTR:

- provisions for utilizing ferric chloride or alum as the primary coagulant
- refurbishing and reactivating the flocculator
- provide an adequate monitoring plan and sampling equipment for turbidity, flow and disinfection
- provide adequate disposal site for backwash waste water, such as improvements to the backwash pond, discharging to the existing sewage facility, or discharging to a permitted location
- provide additional certification and training for the operator and back-up operator (Grade II license is required for treatment and distribution)
- provide an approved operations plan
- provide an adequate ventilation/exhaust system for the chlorine gas
- provide an emergency chlorine repair kit.
- provide filter-to-waste provisions
- provide surface wash or air scour for backwashing efficiency

A discussion of these improvements was presented in the previous section. Design and construction costs for the improvements were estimated and used as a basis for comparison with other alternatives for SWTR compliance. This comparison is presented in Section V.

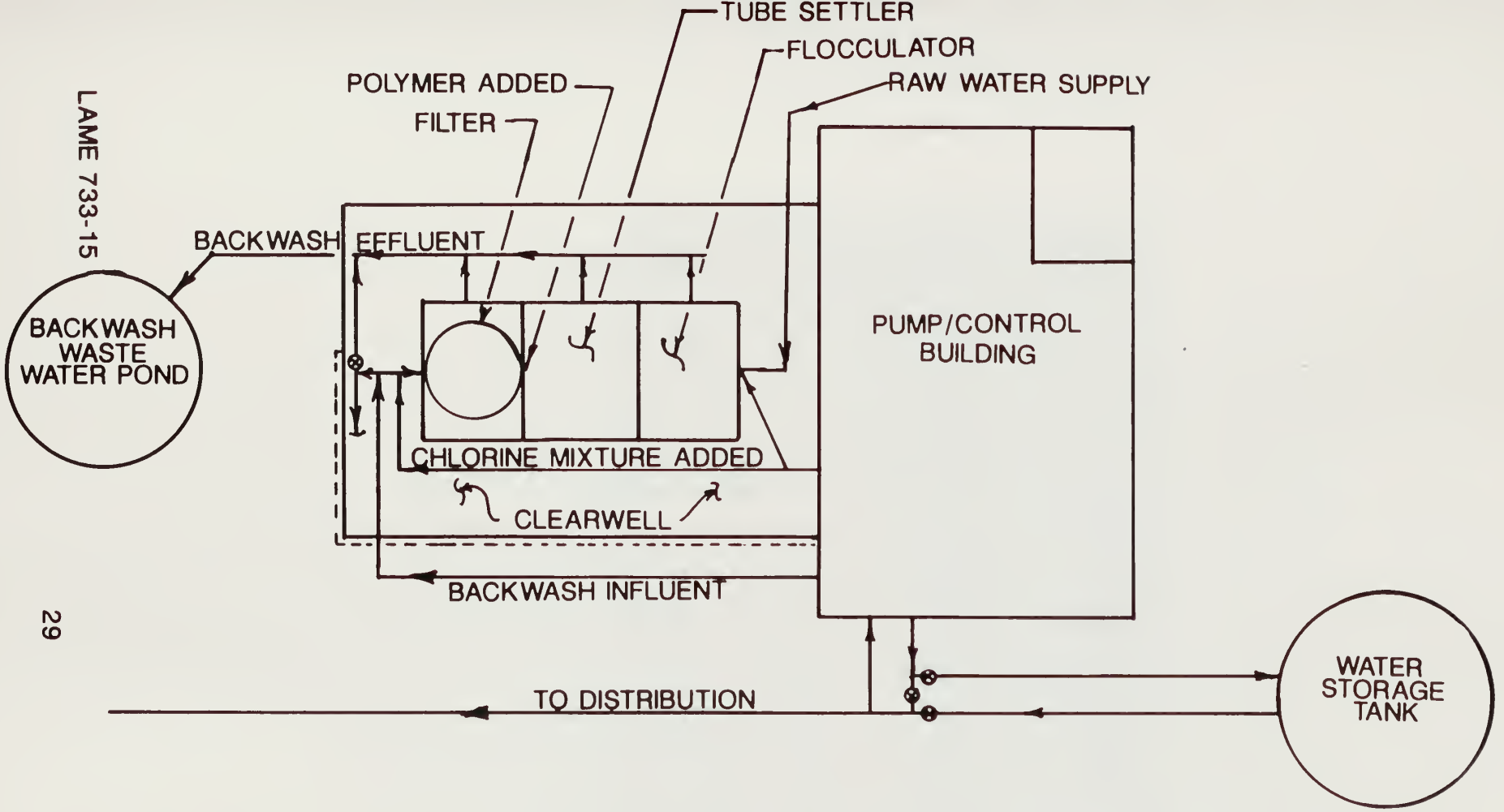




**FIGURE 20** FLOW DIAGRAM FOR THE OVERTON BEACH WATER TREATMENT PLANT

**Figure 21 - OVERTON BEACH WATER TREATMENT PLANT**
Overview of the plant. Water storage tank, not shown, overlooks the plant.

**Figure 22 - OVERTON BEACH WATER TREATMENT PLANT** View of filters and flocculator of package treatment plant. This plant, located outside, is subject to weathering. Notice the damaged pipe insulation.

**Figure 23 - OVERTON BEACH WATER TREATMENT PLANT** Inadequate pipe insulation.

## KATHERINE

### EXISTING CONDITIONS

Katherine Landing, or more commonly, Katherine, is located in Arizona at the southern edge of the recreational area on Lake Mohave, just upstream of Davis Dam. Laughlin, Nevada, is within five miles of this development. Visitation to Katherine has experienced rapid growth over the last ten years, which is significantly higher than any other development within the recreational area. This growth is mainly attributed to the casino related businesses found at Laughlin. Katherine visitors commonly participate in water sport activities such as: waterskiing, boating, etc. The annual average visitation is 3,739 people per day.

Raw water is obtained from an isolated cove on Lake Mohave by two end suction centrifugal pumps with 500 and 250 gpm capacities. The pumps are located on a floating barge. The barge pontoons and deck have rusted. The raw water is pumped from the lake to a water treatment plant 70 feet above the intake barge.

The raw water is treated at a 0.35 mgd filtration plant. The raw water quality is excellent and the average influent turbidity is 0.58 NTU. The raw water is pumped from the intake barge to a 18.5-foot diameter basin and clarified. A polymer and chlorine solution are then added prior to filtration by three dual media filters. The average and peak filtration rates are 1.1 and 2.1 gpm/sf. The waste water from the backwashing of the filters is permitted, by the state and USEPA under NPDES, to discharge to the adjacent gully. Disinfection is accomplished by injecting the treated water with a chlorine gas solution prior to discharge into the clearwell. The finished water is finally pumped to the water storage tank (see figures 24, 25, 26, 27, and 28). The computed CT value is 1.2 with conditions of a residual chlorine concentration of 0.6 mg/l, water temperature of 20 degree celsius, and pH of 7.5. The computed CT value is more than the minimum allowable CT value of 1. The average effluent turbidity is 0.19 NTU.

Presently, Katherine has one aboveground steel storage tank with the capacity of 500,000 gallons. The projected future average monthly water demand will be 290,000 gpd. The fire flow required for a 2-hour, 1,000 gpm demand is 120,000 gpd. Thus, the total future water storage volume requirement is 410,000 gallons, and Katherine now has sufficient water storage.

## SWTR DEFICIENCIES

The state of Arizona has not yet specified which improvements, if any, will be required for compliance with the SWTR. However it is anticipated that they will be similar to those cited for the other treatment facilities detailed in this study. The cost estimate for SWTR compliance improvements are based on the average expense that is estimated for all the other five water treatment plants in this study.

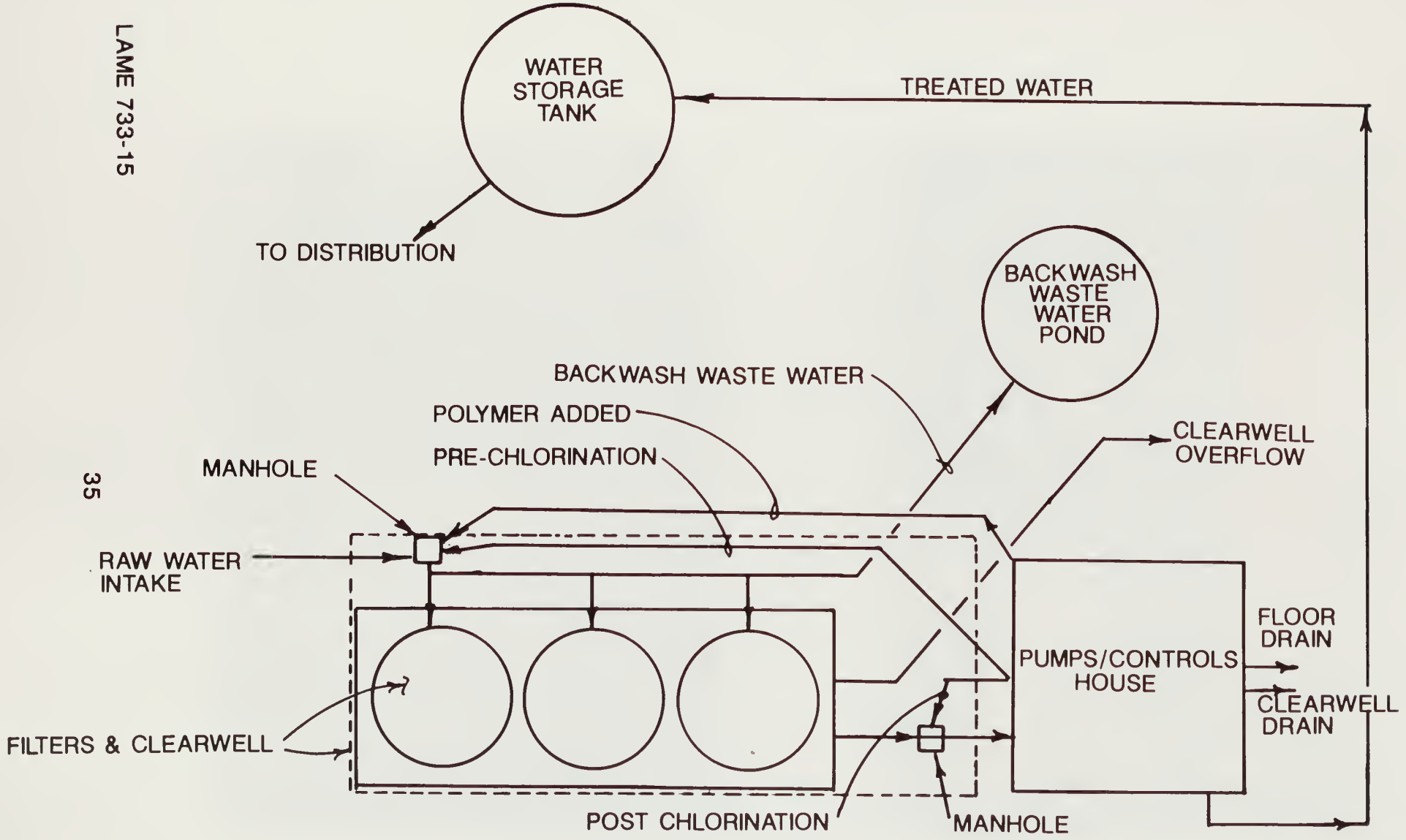


**FIGURE 24** FLOW DIAGRAM OF THE KATHERINE WATER TREATMENT PLANT

**Figure 25 - KATHERINE WATER TREATMENT PLANT** Intake barge and pipeline.

**Figure 26 - KATHERINE WATER TREATMENT PLANT** North entrance to pump house.

**Figure 27 - KATHERINE WATER TREATMENT PLANT**
Backwash waste water pond.

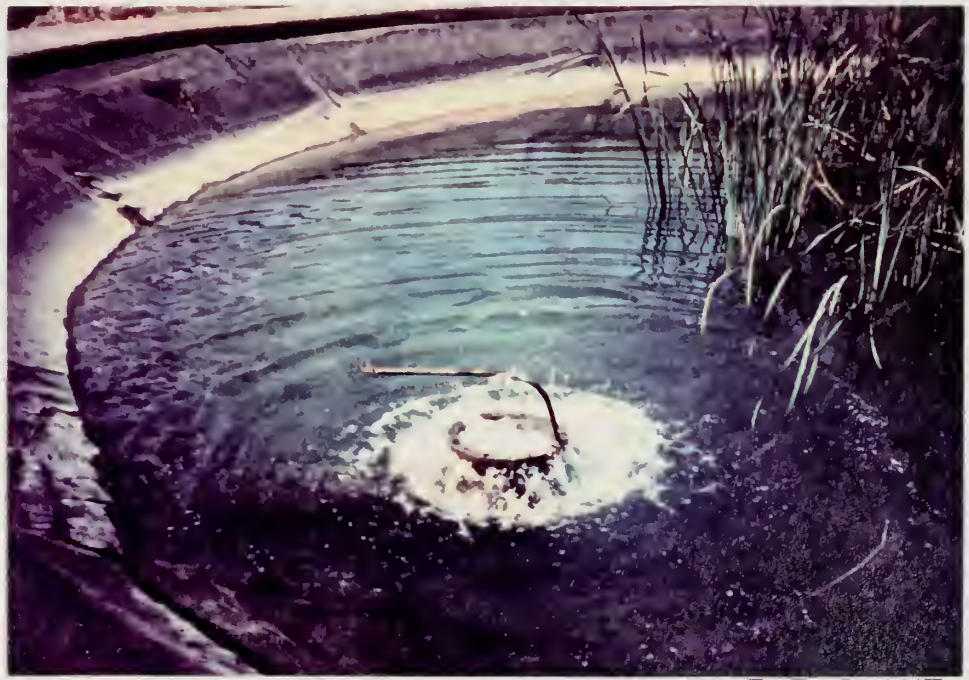

**Figure 28 - KATHERINE WATER TREATMENT PLANT**
Backwash water filling the pond during a backwashing operation.

## III. GENERAL DESCRIPTION OF BASIC OPTIONS

In order to meet the requirements of the SWTR, there are a number of possible alternatives. Alternatives would fall into one of two basic categories: treatment of present sources or development of an alternative source.

### TREATMENT OF PRESENT WATER SOURCES

The alternative processes mentioned in the EPA Guidance Manual for treatment of surface water in compliance with the SWTR are:

A. **Conventional Treatment** (coagulation, flocculation, sedimentation, rapid sand filtration). This process, as the name implies, has been the standard approach taken by the industry in treating surface waters for potable use for many years. The technology is very well proven, and is very flexible for adaptation to produce excellent results under conditions of varying raw water quality. Each of the steps in the process train requires a properly sized treatment tank, with associated mechanical equipment for introduction of chemicals, mixing, flocculation, sludge and scum removal, and filter washing (see figure 29). Generally, each of these components is provided in duplicate to assure reliability.

B. **Direct Filtration** (coagulation, filtration). Direct Filtration can have several different pretreatment unit processes depending upon the application. The simplest form of process includes only application of a chemical coagulant, mixing and filtration (see figure 30). The mixing step can be accomplished by turbulence in the pipe on the way to the filter by a static mixer or by the use of a flocculator. Direct Filtration has obvious economic advantages over the other filtration alternatives since less tankage, equipment, land area, and operator sophistication are required. For the systems at Lake Mead, existing filtration equipment can also be utilized for the remainder of its life cycle, which enhances such an alternative economically.

C. **Slow Sand Filtration.** Slow sand filtration is a well established and proven technology that has experienced a recent resurgence in popularity, particularly for smaller, more remote systems due to its relative simplicity and low operational requirements. Compared to rapid sand (conventional) filtration, slow sand filtration has a lower surface flow rate, finer-grained sand is used for the medium, filter cleaning is accomplished by removing the surface layer of the sand rather than backwashing (which is common in direct filtration), much longer run times are possible between cleanings, and a "ripening" period is required at the beginning

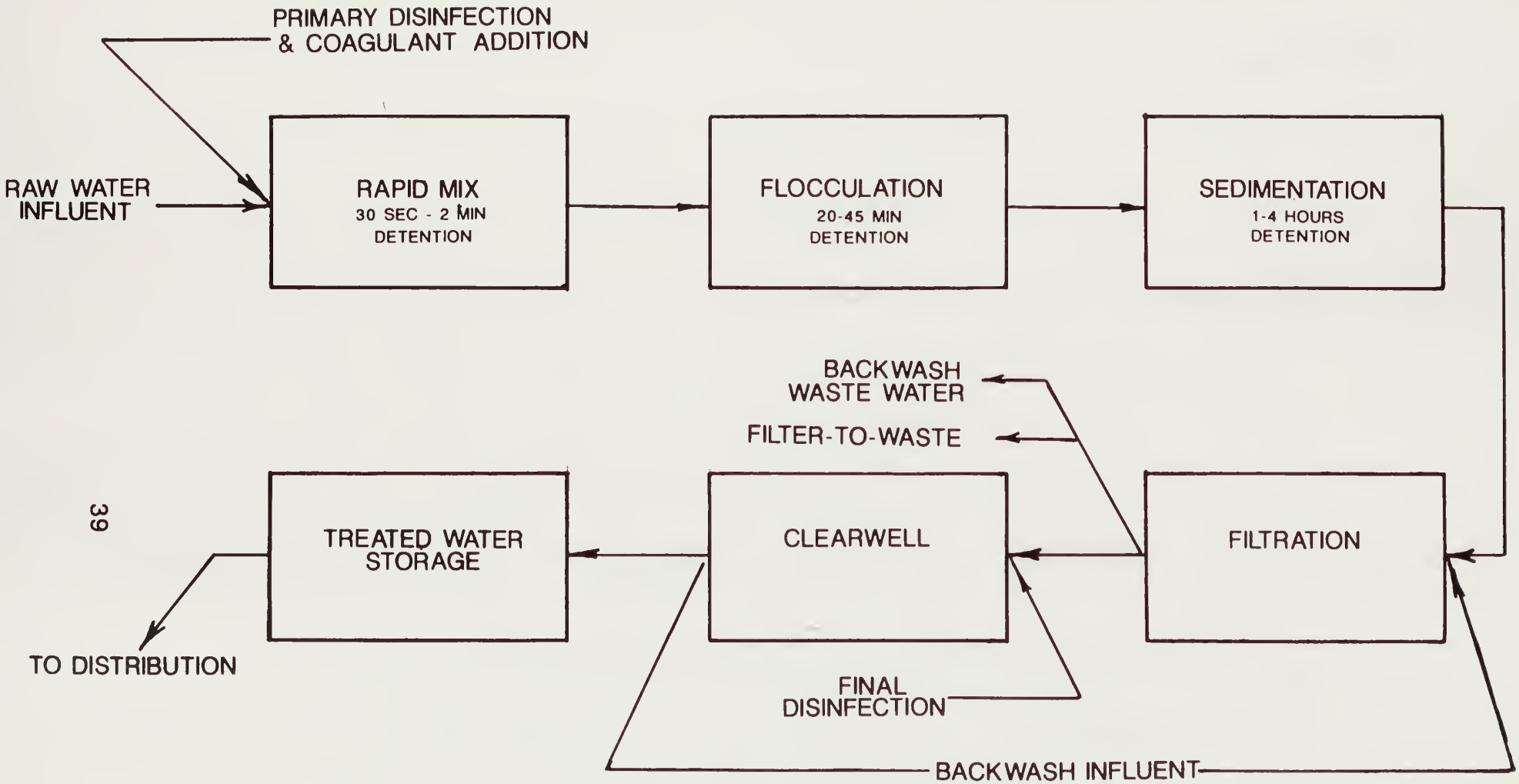




**FIGURE 29** FLOW DIAGRAM FOR A TYPICAL CONVENTIONAL WATER TREATMENT PLANT

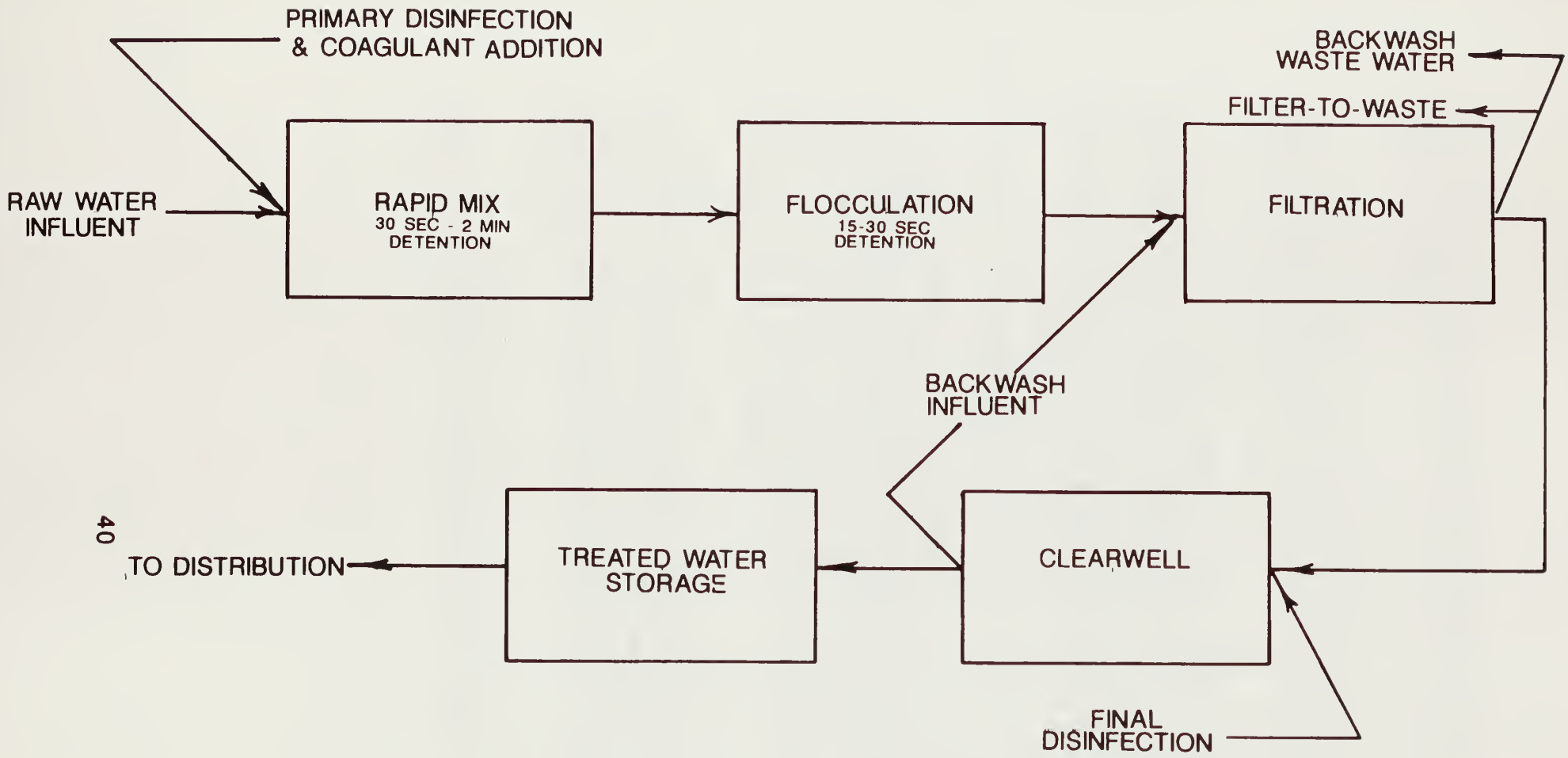


**FIGURE 30** FLOW DIAGRAM FOR A TYPICAL DIRECT FILTRATION PLANT WITH FLOCCULATION

of each filter run before effective treatment occurs. Startup of a slow sand filter requires several weeks to several months for the biological population in the medium to mature.

Slow sand filtration has obvious advantages related to operational simplicity and low energy requirements. Disadvantages include the area required for the filters themselves, and (at Lake Mead) the economic impact for construction of a completely different facility for each site.

D. **Diatomaceous Earth Filtration (DE)**. Diatomaceous earth filtration is appropriate for direct filtration treatment of surface waters for the removal of relatively low levels of turbidity and microorganisms. Diatomite filters consist of a layer of diatomaceous earth supported on a septum or filter element. The thin precoat layer of diatomaceous earth must be supplemented by a continuous body feed of diatomite, which is used to maintain the porosity of the filter cake.

E. **Alternative Technologies** (requires state approval)

1. **Cartridge Filtration**. Cartridge filtration is a simple filtration process that uses an artificial filter medium with increasingly fine pore sizes in a cartridge configuration, which requires disposal of spent cartridges after a certain useful life. Usually, these cartridges are clustered in a housing, sized for the design flow rate, with two or more of these housings arranged in series to provide progressively finer pore sizes. When head loss through the filters reaches a certain maximum, the cartridges are simply replaced.

2. **Package Plants**. Package plants are available in numerous types and configurations, but generally are premanufactured units that employ conventional treatment technology. These plants also find application in small flow regimes, primarily due to economies of scale. They are also available for larger flows. The useful service life of package plants are highly variable, which must be taken into consideration.

Overton Beach has the only package plant that will be discussed in this report, which is in need of some improvements to make it more efficient and to comply with the SWTR.

F. **New Construction Alternatives Not Considered**

Due to the upward climb of new construction costs, it has become obvious that building a new treatment plant would be less economical than upgrading any of the existing plants. The Echo Bay water treatment plant is an exception due to the condition of the existing facility. The following water treatment alternatives will not be considered due to the obvious reasons mentioned:

- Conventional Treatment will not be evaluated in-depth in this study as an option where the basic facilities required do not already exist, due to the fact that it would require the most new construction, operation and maintenance, and therefore would be one of the most costly alternatives.
- Slow sand filtration will also not be further considered as an alternative due to the extent of expensive construction required, and the area required to develop it.
- Diatomaceous earth filtration will not be considered for this engineering study because of the commonly reported problems with the filtering quality, short filter runs, availability of replacement medium and the extent of construction required.
- Cartridge filtration is generally economical for only very small flows, and for the Lake Mead developments it will also not be further considered due to the initial capital costs, high operation and maintenance costs, and requirement for state approval.
- Package Plants will not be considered for any of the Lake Mead sites because the initial cost would obviously be greater than upgrading the existing plant.

## ALTERNATIVE SOURCES

A. **Groundwater - Developing a new groundwater supply from wells.**
The groundwater quality at Lake Mead is relatively constant season to season, and is usually superior to that of surface water with respect to bacteriological content, turbidity and total organic concentration. However, mineral content may be greater and there is often an increase in pumping costs compared with surface water utilization.

This alternative accomplishes compliance with the Surface Water Treatment Rule by negating its applicability. Two or more wells are being proposed to provide redundancy, required by the SWTR and adequate quantity.

Another potential pitfall is that optimum location of production wells may be in dry washes or alluvia subject to flash flooding which could damage or destroy physical facilities and result in temporary contamination.

The wells under consideration in this study will require hydrologic and laboratory data to confirm that they are not influenced by surface water. If the groundwater is proven to be quality, the water would only require disinfection before it is distributed.

B. **Water from suppliers outside Lake Mead N.R.A.** Connecting to a community system outside of the park is attractive as an alternative because of its simplicity and straightforwardness. With this alternative, water would presumably already be treated in compliance with all the applicable regulations. The connection would consist of one or more taps and appurtenances to supply the whole development. The advantages would include sufficiency of water pressure, quantity at all times, and less manpower needed. Receiving water from a supplier eliminates the need to make improvements to the existing facilities to comply with the SWTR or any future federal regulations that may come into affect. Also, a rate will be charged for the water usage making budgeting a much simpler process. The supplier might also be willing to assume responsibility for the maintenance and service of the existing distribution system, which might enhance the attractiveness of such an option, depending on the specific arrangements.

## IV. BASIS OF COMPARISON OF ALTERNATIVES

There are numerous methods which can be used for the comparison of alternatives for the purpose of selecting a preferred one. The discipline of Value Engineering or Value Analysis is a very organized, methodical framework for accomplishing this goal. One of the early steps in the process of value analysis is to establish and weight criteria by which the alternatives generated will be evaluated. Normally, one of the primary criteria used is that of life-cycle cost, which is the basis of most engineering economic analyses. For NPS projects, other criteria which often are considered with equal, more or less weight include environmental and resource impacts, the ability to be implemented, maintainability, reliability, safety, visual impact, sustainability, and others. Since this study is not a pure value engineering study, the alternatives will be reviewed and compared through an economic analysis first, with a discussion of the other potential criteria for the most economically attractive alternatives later.

In using an economic analysis to compare the alternatives for SWTR compliance at Lake Mead, there has been an attempt to make simplifying assumptions while preserving the integrity of the analysis. Many of these assumptions are based on the rules set forth in the U.S. Office of management and Budget's Circular A-94, "Discount rates to be used in Evaluating Time Distributed Costs and Benefits." These include the discount rate assumed for the time value of money, which is 10 percent.

Other assumptions include the following:

- Prices of water supplied by outside utilities will not change significantly, except to reflect prevailing interest rates, or the time value of money.

- Operation and maintenance costs presently incurred for the water systems at each of the developed areas are distributed 85 percent to the treatment plants and 15 percent to the distribution and storage systems.

- Each alternative will have a 20-year useful life.

- Design costs for any capital improvements are estimated to be 25 percent of gross construction costs.

The following table illustrates the simplified accounting used in developing the equivalent present worth cost of the alternatives:

| DEBITS | CREDITS |
|---|---|
| Capital Improvement Costs (design costs, costs for purchase of easements/rights of way, construction costs, contract administration costs) | Receipts from Sale of Property |
| Operating Costs (salaries, benefits, supplies, materials, overhead costs) | Receipts from Sale of Water |
| Maintenance Costs (replacement parts, painting, overhauls, equipment replacements) | |
| Costs to Purchase Water | |

A further simplifying assumption is that the "receipts from the sale of water" will be the same for all alternatives. This assumption simplifies the analysis by allowing this credit to be dropped from consideration. The lone exception to this assumption is the alternative for sale of the water system infrastructure to Citizens Utilities at Katherine, under which there would be no receipts by the park from sale of water. This exception is accommodated by including a cost for purchase of water which would actually be incurred by the park's current "customers" as a debit in the accounting for this alternative, whereas there actually would be no cost to the park for this water.

## V. DESCRIPTION OF ALTERNATIVES FOR EACH DEVELOPMENT

### BOULDER BEACH

Three alternatives will be analyzed for Boulder Beach: developing a new groundwater supply from wells, converting the existing plant to operate in a direct filtration mode as prescribed by the EPA and state of Nevada, and connecting to a neighboring municipality's (Boulder City) water utility.

### ALTERNATIVES

#### 1. Groundwater Supply

Developing a new groundwater supply from wells will involve drilling and developing two or more wells, providing pumps, piping, appurtenances, and disinfection equipment; and providing appropriate structures to house them. These facilities would be similar to those that exist in the park at Cottonwood Cove, Temple Bar and Willow Beach.

| Present Worth Cost | |
|---|---|
| Gross Construction | $ 360,000 |
| Design Costs | $ 70,000 |
| Present Worth O&M Costs | $ 600,000 |
| Total Present Worth: | $1,030,000, say $1,000,000 |

(These costs do not include those for demolition and site restoration of existing surface water treatment facilities.)

#### 2. Converting to Direct Filtration

Converting to direct filtration will involve several improvements to the existing treatment facility to comply with the Nevada SWTR. These improvements would correct the deficiencies listed in the previous section.

Additional improvements that are not required for the compliance with the SWTR, but which would be recommended to be included in a construction contract to upgrade the facility are as follows:

- construct comfort facilities for the operators
- provide a 10-inch isolation valve outside the pump house
- repair the filter underdrains
- improve the climate control equipment
- connect the visitor's center to Boulder City's water distribution system

The additional improvements listed above are recommended to improve the operating conditions and reliability of the existing water treatment facility. The comfort facilities and climate control equipment are recommended at each water treatment facility in this study to provide a certain level of comfortable conditions for each operator.

The isolation valve and the repair and modifications to the underdrains are recommended to provide more plant operating efficiency.The existing valve that isolates the plant from the distribution system is located several miles from the actual plant which is an undesirable situation in case of plant contamination. The underdrains will require replacement due to their deteriorated condition.

The visitor's center should be connected to Boulder City's water system to ensure sufficient pressure and fire flow protection. Presently, the existing storage volume is undersized for the existing demand on it.

| SWTR Compliance Present Worth Cost | |
|---|---|
| Gross Construction | $ 290,000 |
| Design Cost | $ 70,000 |
| Present Worth O&M Costs | $1,110,000 |
| Total SWTR Present Worth: | $1,470,000, say $1,500,000 |

| Additional Improvements Present Worth Cost | |
|---|---|
| Gross Construction | $ 280,000 |
| Design Cost | $ 70,000 |
| Total Additional Improvements Present Worth | $ 350,000 |

| | |
|---|---|
| TOTAL PRESENT WORTH FOR SWTR AND ADDITIONAL IMPROVEMENTS | $1,820,000, say $1,800,000 |

### 3. Connection to a Municipality

Another alternative is the connection to a water system of the neighboring municipality of Boulder City. This alternative provides the park an option to eliminate water supply and treatment at Boulder Beach. Southern Nevada Water System supplies Boulder City with potable water by means of an existing 36-inch main that crosses park property.

This alternative involves tapping the 36-inch main with a 8-inch tapping sleeve (see figure 31). The connection also would consist of a 8-inch meter, 8" valves, Remote Terminal Unit (RTU), electrical power, concrete housing, approximately 210 feet of 8-inch pipe, and an air gap at the Boulder Beach storage tank to prevent backflow and to isolate both systems (required by Southern Nevada Water System). The RTU is a control that is required by the Southern Nevada Water System for operating the new 8-inch valve at the Boulder Beach connection, from the SNWS treatment plant.

| Present Worth Cost | |
|---|---|
| Gross Construction | $ 246,000 |
| Design Costs | $ 60,000 |
| Present Worth Monthly Charges | $2,900,000 |
| Present Worth O & M Costs | $ 170,000 |
| TOTAL PRESENT WORTH FOR BOULDER BEACH CONNECTION | $3,376,000, say $3,400,000 |

(These costs do not include those for demolition and site restoration of existing surface water treatment facilities.)

## RECOMMENDATION

The Boulder Beach water treatment plant does not comply with the Surface Water Treatment Rule. There are several alternatives available for achieving compliance. Upgrading the treatment facilities to direct filtration plant, development of a groundwater supply, and connection to a nearby municipal water utility were evaluated based on cost, feasibility and operation and maintenance requirements.

From an economic and engineering standpoint, it is recommended that development of a groundwater supply be pursued for potable water supply.

Lower construction costs and annual operation and maintenance costs make groundwater development more attractive than treatment plant improvements.

A recommendation for development of a groundwater supply is contingent upon the results that will come from hydrologic and laboratory analyses for the availability and acceptability of the groundwater in the area.

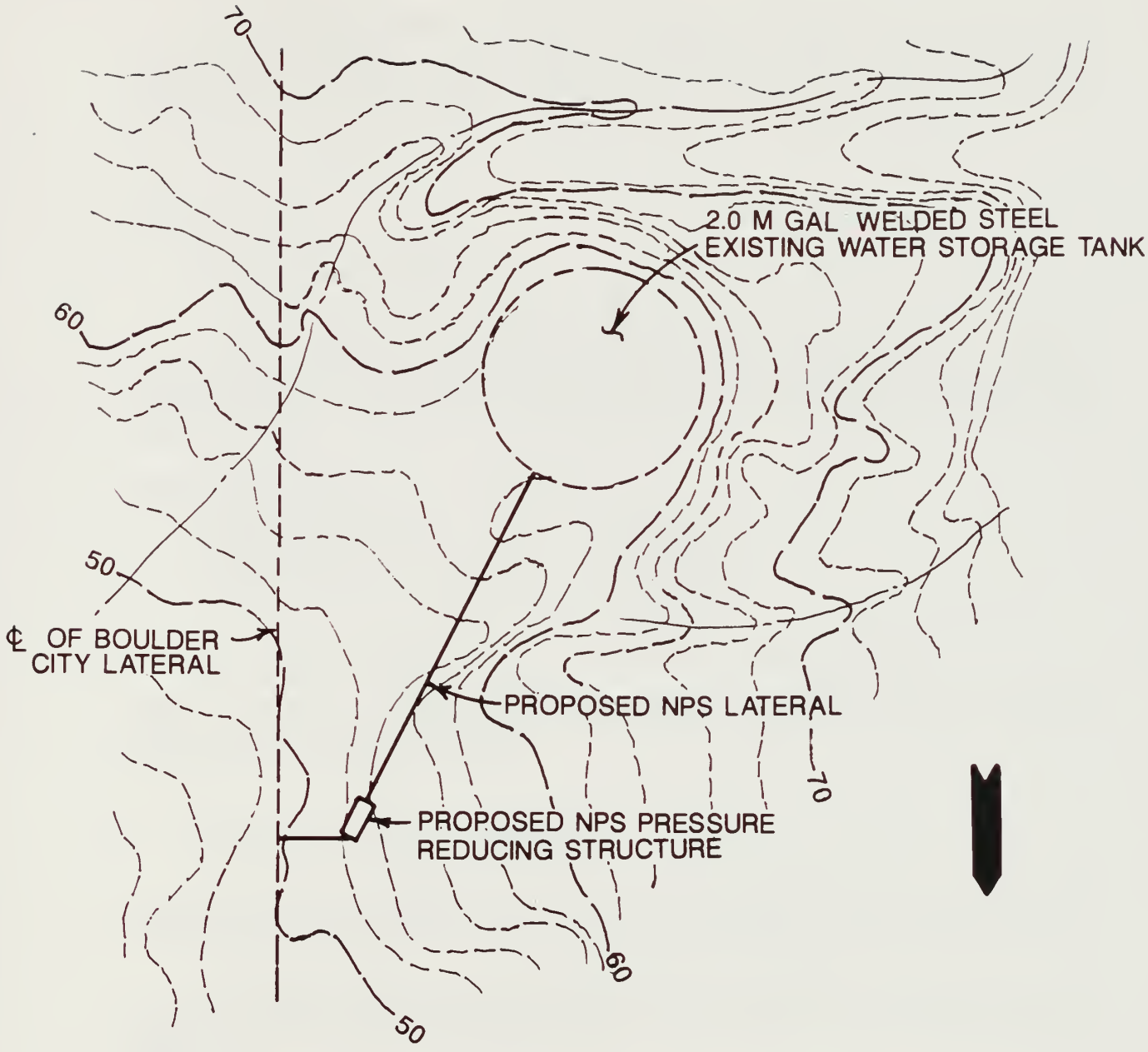


**FIGURE 31** SCHEMATIC DETAIL FOR BOULDER BEACH CONNECTION TO BOULDER CITY LATERAL

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## CALLVILLE BAY

Two alternatives will be evaluated to bring Callville Bay into compliance with the SWTR: developing a groundwater supply from wells and converting the existing plant to direct filtration. The nearest municipality supplier of water is located many miles from Callville Bay, making it an impractical alternative.

### ALTERNATIVES

#### 1. Groundwater Supply

As previously stated, developing a new groundwater supply from wells will involve drilling and developing two or more wells, providing pumps, piping, appurtenances, and disinfection equipment; and providing appropriate structures to house them.

Present Worth Cost

| | |
|---|---|
| Gross Construction | $ 360,000 |
| Design Costs | $ 70,000 |
| Present Worth O&M Costs | $ 600,000 |
| Total Present Worth | $1,030,000 say $1,000,000 |

(These costs do not include those for demolition and site restoration of existing surface water treatment facilities.)

#### 2. Converting to Direct Filtration

Improvements required to comply with the SWTR and convert to direct filtration would essentially correct the deficiencies listed in the previous section.

Additional improvements, not required by SWTR for compliance, which would be recommended to be included in a construction contract to upgrade the facility are:

- construct a 80,000 gallon water storage tank
- construction of comfort facilities for the operator
- providing a separation for the laboratory
- improvements to the climate control equipment

- provide a programmable logic controller (PLC) and personal computer with modem for remote control and alarm
- relocate the fill pipe for the storage tank to the top
- replace the intake barge

These improvements listed above are recommended to improve the operating conditions and reliability of the existing water treatment facility. The comfort facilities, laboratory separation, and climate control equipment are recommended for each water treatment facility to provide adequate working conditions for each plant operator. The PLC and personal computer is recommended since the plant operator is not present at the plant 24 hours a day and may need to control the operation from a remote location.

The existing storage capacity is insufficient for domestic demand therefore an additional treated water storage tank is recommended. The fill pipe on the existing storage tank should be relocated to prevent backflow and contamination.

The intake barge is in need of repair in the near future. The floats and deck have rusted and the pumps have had minimal maintenance performed. The entire barge should be replaced.

| SWTR Compliance Present Worth Cost | |
|---|---|
| Gross Construction | $ 460,000 |
| Design Cost | $ 120,000 |
| Present Worth O&M Costs | $ 760,000 |
| Total SWTR Present Worth: | $1,340,000, say $1,300,000 |

| Additional Improvements Present Worth Cost | |
|---|---|
| Gross Construction | $ 490,000 |
| Design Cost | $ 120,000 |
| Total Additional Improvements Present Worth | $ 610,000 |

| | |
|---|---|
| TOTAL PRESENT WORTH FOR SWTR AND ADDITIONAL IMPROVEMENTS | $1,950,000, say $2,000,000 |

## RECOMMENDATION

The Callville Bay water treatment plant does not comply with the SWTR. Two alternatives were evaluated for feasibility, cost, and operation and maintenance in achieving compliance: upgrading the treatment facilities to a direct filtration plant and development of a groundwater supply.

It is recommended that development of a groundwater supply be pursued for potable water supply.

Lower construction costs and annual operation and maintenance costs make groundwater development more attractive than treatment plant improvements.

A recommendation for development of a groundwater supply is contingent upon the results that will come from hydrologic and laboratory analyses for the availability and acceptability of the groundwater in the area.

## ECHO BAY

The condition of Echo Bay's existing water treatment facility is a major consideration when reviewing the alternatives that are feasible for supplying water to the area. The nearest municipality supplier of water is located many miles from Echo Bay, making it an impractical alternative. The alternatives for this development are developing a groundwater source from wells and construction of a new water treatment plant, since the existing plant is near the end of its useful life.

### ALTERNATIVES

### 1. Groundwater Supply

Developing groundwater supply from wells involves far less construction and commitment to operation and maintenance compared to the construction of a new water treatment plant. As previously stated, developing a new groundwater supply from wells will involve drilling and developing two or more wells, providing pumps, piping, appurtenances, and disinfection equipment; and providing appropriate structures to house them.

Present Worth Cost

| | |
|---|---|
| Gross Construction | $ 360,000 |
| Design Costs | $ 70,000 |
| Present Worth O&M Costs | $ 600,000 |
| Total Present Worth | $1,030,000, say $1,000,000 |

(These costs do not include those for demolition and site restoration of existing surface water treatment facilities.)

### 2. New Treatment Plant

A new treatment plant will require extensive, costly new construction. Depending on the type of treatment plant that will replace the existing one, the Nevada SWTR requirements, as listed in the previous section, must be met.

Additional improvements recommended to upgrade the facility or to be included with a new facility are as follows:

- construct comfort facilities for the operator
- the laboratory should be separated from the pump room
- provide adequate climate control equipment
- replace intake barge.

These improvements reasons for recommendation are discussed previously in the Callville Bay discussion.

The water treatment plant that is recommended to replace the existing treatment plant at Echo Bay, and upon which the cost estimates in the economic analysis are based, is a direct filtration package plant. Direct filtration was chosen due to the familiarity that the present operations personnel have with this type of treatment. Direct filtration is more economical than conventional, slow sand filtration and diatomaceous earth due to the reasons stated in the previous section. The package plant is suggested because of its cost advantage and the familiarity of the park's water treatment personnel with similar facilities.

| SWTR Compliance Present Worth Cost | |
|---|---|
| Gross Construction | $ 530,000 |
| Design Cost | $ 130,000 |
| Present Worth O&M Costs | $1,150,000 |
| Total SWTR Present Worth: | $1,810,000, say $1,800,000 |

| Additional Improvements Present Worth Cost | |
|---|---|
| Gross Construction | $ 950,000 |
| Design Cost | $ 240,000 |
| Total Additional Improvements Present Worth | $1,190,000 |

| | |
|---|---|
| TOTAL PRESENT WORTH FOR SWTR AND ADDITIONAL IMPROVEMENTS | $3,000,000 |

## RECOMMENDATION

The Echo Bay water treatment plant does not comply with the SWTR. Two alternatives were evaluated for feasibility, cost, and operation and maintenance in achieving compliance. Upgrading the treatment facilities to direct filtration plant with a new water treatment plant and development of a groundwater supply.

It is recommended that development of groundwater supply be pursued for potable water supply for this area.

Lower construction costs and annual operation and maintenance costs makes the groundwater development more attractive than treatment plant improvements.

A recommendation for development of a groundwater supply is contingent upon the results that will come from hydrologic and laboratory analyses for the availability and acceptability of the groundwater in the area.

## LAS VEGAS WASH

Developing a groundwater supply from wells, connecting to a nearby municipal water system located outside Lake Mead N.R.A., and converting the existing plant to direct filtration, are three alternatives that were considered for Las Vegas Wash.

### ALTERNATIVES

### 1. Groundwater Supply

As previously stated, developing a new groundwater supply from wells will involve drilling and developing two or more wells, providing pumps, piping, appurtenances, and disinfection equipment; and providing appropriate structures to house them.

Present Worth Cost

| | |
|---|---|
| Gross Construction | $ 360,000 |
| Design Costs | $ 70,000 |
| Present Worth O&M Costs | $ 600,000 |
| Total Present Worth | $1,030,000, say $1,000,000 |

(These costs do not include those for demolition and site restoration of existing surface water treatment facilities.)

### 2. Converting to Direct Filtration

The alternative to convert the existing treatment facility to operate in a direct filtration mode and comply with the SWTR will require a number of improvements to the existing facility. These improvements will correct the deficiencies listed in the previous section.

Additional improvements that are not required by SWTR for compliance, but which would be recommended to be included in a construction contract to upgrade the existing facility are:

- construct a new 110,000 gallon storage tank
- provide adequate climate control equipment

- construct comfort facilities for the operator
- provide a separation for the laboratory from the rest of the plant.
- provide piping modifications to use treated water for chlorine solution

These improvements listed above are recommended to improve the operating conditions and reliability of the existing water treatment facility. The comfort facilities, laboratory separation, and climate control equipment are recommended for each water treatment facility to provide adequate working conditions for each plant operator.

Presently, the chlorine solution is mixed with raw water. This is a violation of state standards, and potentially a health hazard. Organisms unaffected by chlorine could be injected into the treated water. The system should be repiped so that treated water is used for the chlorine solution makeup.

| SWTR Compliance Present Worth Cost | |
|---|---|
| Gross Construction | $ 340,000 |
| Design Cost | $ 80,000 |
| Present Worth O&M Costs | $ 980,000 |
| Total SWTR Present Worth: | $1,400,000 |

| Additional Improvements Present Worth Cost | |
|---|---|
| Gross Construction | $ 410,000 |
| Design Cost | $ 100,000 |
| Total Additional Improvements Present Worth | $ 510,000 |

| | |
|---|---|
| TOTAL PRESENT WORTH FOR SWTR AND ADDITIONAL IMPROVEMENTS | $1,910,000, say $1,900,000 |

### 3. Connection to a Municipality

Las Vegas Wash has an alternative to receive water from a source outside the Lake Mead boundary. The source is the City of Henderson water system. The City of Henderson, Nevada sells water to the new Lake Las Vegas Development (approximately 3 miles from Las Vegas Wash) and is willing to sell water to the park service. An agreement between the City of Henderson and the Lake Las

Vegas Development was signed prior to initial construction for the development. This agreement, in general terms, stated that once the Lake Las Vegas development's distribution system was completed the ownership of the water system would be transferred to the City of Henderson. The City of Henderson would then be responsible for the operation and maintenance of this water system.

The water would be supplied to the Las Vegas Wash storage tank through the Lake Las Vegas development's distribution system (see figure 32). The water will be metered at the park service boundary and the cost of the water will be figured this way. This alternative will require the construction of a water line, valves, a meter, and improvements to oversize the Lake Las Vegas Development water system.

| Present Worth Cost | |
|---|---|
| Gross Construction | $ 650,000 |
| Design Costs | $ 160,000 |
| Present Worth Monthly Charges | $ 660,000 |
| Present Worth O & M Costs | $ 150,000 |
| LLV Development Charges | $ 260,000 |
| TOTAL PRESENT WORTH FOR LAS VEGAS WASH CONNECTION | $1,880,000 say, $1,900,000 |

(These costs do not include those for demolition and site restoration of existing surface water treatment facilities.)

## RECOMMENDATION

The Las Vegas Wash water treatment plant does not comply with the SWTR. There are several alternatives available for achieving compliance; upgrading the treatment facilities to direct filtration plant, development of a groundwater supply, and connection to a nearby municipal water utility were evaluated based on cost, feasibility and operation and maintenance requirements.

From an economic and engineering standpoint, it is recommended that development of groundwater supply be pursued for potable water supply for this area.

Lower construction costs and annual operation and maintenance costs makes the groundwater development more attractive than treatment plant

improvements, and connection to a nearby municipal water utility.

A recommendation for development of a groundwater supply is contingent upon the results that will come from hydrologic and laboratory analyses for the availability and acceptability of the groundwater in the area.

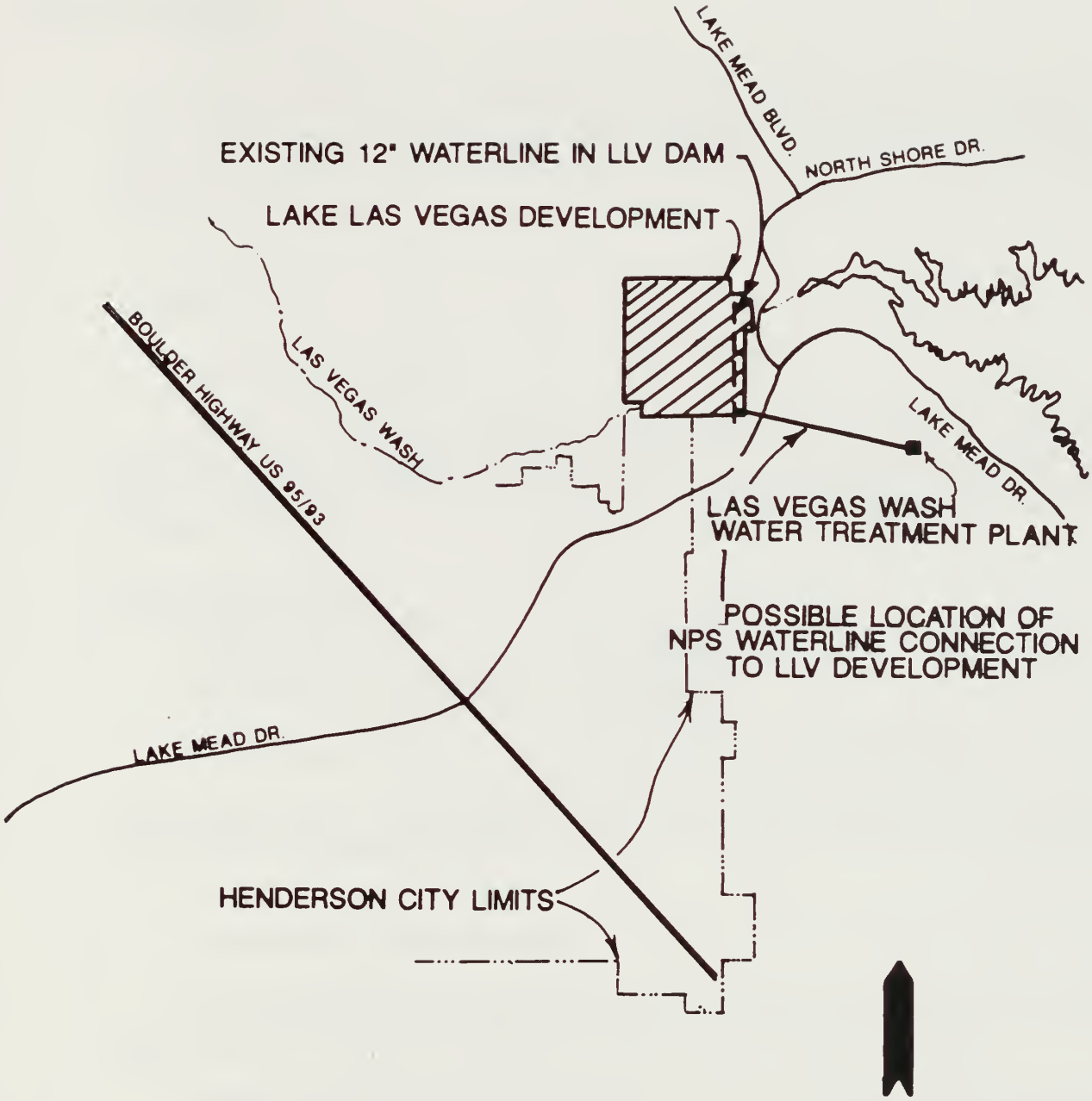


**FIGURE 32** LAKE LAS VEGAS DEVELOPMENT AND LAS VEGAS WASH WATER TREATMENT PLANT REGIONAL MAP

LAME 733-15

## OVERTON BEACH

Overton Beach has two feasible alternatives that will be studied: developing a groundwater supply from wells and converting the existing plant to operate in a direct filtration mode in compliance with the SWTR. The nearest municipality supplier of water is located many miles from Overton Beach, making it an impractical alternative.

### ALTERNATIVES

#### 1. Groundwater Supply

As previously stated, developing a new groundwater supply from wells will involve drilling and developing two or more wells, providing pumps, piping, appurtenances, and disinfection equipment; and providing appropriate structures to house them.

Present Worth Cost

| | |
|---|---|
| Gross Construction | $ 360,000 |
| Design Costs | $ 70,000 |
| Present Worth O&M Costs | $ 600,000 |
| Total Present Worth | $1,030,000, say $1,000,000 |

(These costs do not include those for demolition and site restoration of existing surface water treatment facilities.)

#### 2. Converting to Direct Filtration

The alternative of converting the existing plant to direct filtration involves improvements to correct the deficiencies listed in the previous section.

Additional improvements, not required for the compliance with the SWTR, but which would be recommended to be included in a construction contract to upgrade the existing facility are:

- construct enclosures for pipes and appurtenances due to freezing
- provide adequate climate control equipment
- replace raw water pumps.

These improvements listed above are recommended to improve the operating conditions and reliability of the existing water treatment facility. The climate control equipment is recommended to provide better working conditions for the plant operators.

Building an enclosure around the plant is recommended to prevent some operational and maintenance problems experienced in the past. Algae blooms have developed in the open units, though this has been controlled with the use of plywood covers. Valves and pipes have frozen. Even though subfreezing temperatures are infrequent, the problem must be eliminated to provide uninterrupted operation of the facility.

The intake pumps are in need of overhaul or replacement. The pumps are vibrating excessively upon startup. Removal is recommended to determine the cause of the vibration, at which time overhaul or replacement can be recommended as appropriate.

| SWTR Compliance Present Worth Cost | |
|---|---|
| Gross Construction | $ 290,000 |
| Design Cost | $ 70,000 |
| Present Worth O&M Costs | $1,190,000 |
| Total SWTR Present Worth: | $1,550,000, say $1,600,000 |

| Additional Improvements Present Worth Cost | |
|---|---|
| Gross Construction | $ 110,000 |
| Design Cost | $ 30,000 |
| Total Additional Improvements Present Worth | $ 140,000 |

| | |
|---|---|
| TOTAL PRESENT WORTH FOR SWTR AND ADDITIONAL IMPROVEMENTS | $1,690,000, say $1,700,000 |

**RECOMMENDATION**

The Overton Beach water treatment plant does not comply with the SWTR. Two alternatives were evaluated for feasibility, cost, and operation and maintenance in achieving compliance: upgrading the treatment facilities to a

complying direct filtration plant, and development of a groundwater supply.

From an economic and engineering standpoint, it is recommended that development of groundwater supply be pursued for potable water supply to this area.

Lower construction costs and annual operation and maintenance costs make groundwater development more attractive than treatment plant improvements.

A recommendation for development of a groundwater supply is contingent upon the results that will come from hydrologic and laboratory analyses for the availability and acceptability of the groundwater in the area.

## KATHERINE

Katherine's existing water treatment plant is in the best overall condition, compared to the other five existing treatment plants examined in this study. There are three alternatives that will be reviewed in depth for this development: developing groundwater supply from wells, converting the existing plant to direct filtration, or receiving treated water from a public municipality (Bullhead City - Citizens Utilities).

### ALTERNATIVES

### 1. Groundwater Supply

As previously stated, developing a new groundwater supply from wells will involve drilling and developing two or more wells, providing pumps, piping, appurtenances, and disinfection equipment; and providing appropriate structures to house them.

| Present Worth Cost | |
|---|---|
| Gross Construction | $ 360,000 |
| Design Costs | $ 70,000 |
| Present Worth O&M Costs | $ 600,000 |
| Total Present Worth | $1,030,000, say $1,000,000 |

(These costs do not include those for demolition and site restoration of existing surface water treatment facilities.)

### 2. Converting to Direct Filtration

The alternative of converting the existing plant to operate in a direct filtration mode, in compliance with the SWTR, requires improvements to correct the deficiencies listed in the previous section.

Additional improvements, not required by the SWTR, are recommended to be included in a construction contract to upgrade the existing facility, are:

- construct comfort facilities for the operator
- provide laboratory separation from the rest of the plant

- construct separate inflow pipe to water storage tank from treatment plant
- rehabilitate the intake barge
- provide adequate climate control equipment
- provide fire hydrants for the maintenance facility.

The improvements listed above are recommended to improve the operating conditions and reliability of the existing water treatment facility. The comfort facilities, laboratory separation, and climate control equipment are recommended to provide adequate working conditions for the plant operator.

Separating the inflow pipe to the water storage tank from the treatment plant would significantly increase the current marginal CT value.

The intake barge is in need of repair which must occur in the near future. The floats and deck have rusted and the pumps are in deteriorating condition. The entire barge should be replaced.

At the maintenance facility, fire protection is substandard because the number of fire hydrants are inadequate to provide the coverage required per the Uniform Fire Code and NFPA standards.

The waste from the backwashing has been permitted, by the state and USEPA, to discharge to the adjacent gully.

| SWTR Compliance Present Worth Cost | |
|---|---|
| Gross Construction | $ 280,000 |
| Design Cost | $ 70,000 |
| Present Worth O&M Costs | $1,230,000 |
| Total SWTR Present Worth: | $1,580,000, say $1,600,000 |

| Additional Improvements Present Worth Cost | |
|---|---|
| Gross Construction | $ 380,000 |
| Design Cost | $ 90,000 |
| Total Additional Improvements Present Worth | $ 470,000 |

| | |
|---|---|
| TOTAL PRESENT WORTH FOR SWTR AND ADDITIONAL IMPROVEMENTS | $2,050,000, say $2,100,000 |

### 3. Connection to a Municipality

Receiving potable water from a neighboring municipality's water system presents an opportunity for the park to get out of the water treatment business at Katherine. This will be accomplished by the transfer of ownership of the water treatment plant and the distribution system. The possible purchaser is Citizen's Utilities in Bullhead City, Arizona. They have indicated a willingness to purchase available treatment plants and distribution systems including the Katherine facility. They would evaluate the upgrading of the existing systems to comply with the SWTR, and operate, maintain and service it.

Present Worth Cost

| | |
|---|---|
| Gross Construction | ($ 160,000) |
| Present Worth Monthly Charges | $1,330,000 |

TOTAL PRESENT WORTH OF THE PURCHASE OF KATHERINE WTP & DISTRIBUTION SYSTEM $1,170,000, say $1,200,000

(These costs do not include those for demolition and site restoration of existing surface water treatment facilities.)

## RECOMMENDATION

The state of Arizona has not yet cited the Katherine water treatment plant for lack of compliance with the SWTR. It is anticipated that the State will require Katherine water treatment plant to comply in the near future. Therefore three alternatives were evaluated for achieving the anticipated compliance requirements: upgrading the treatment facilities to a complying direct filtration plant, development of a groundwater supply, and conversion to a nearby municipal water utility. These alternatives were based on cost, feasibility and operation and maintenance requirements.

From an economic and engineering standpoint, it is recommended that development of groundwater supply be pursued for potable water supply to this area.

Lower construction costs and annual operation and maintenance costs make groundwater development more attractive than treatment plant improvements.

A recommendation for development of a groundwater supply is contingent upon the results that will come from hydrologic and laboratory analyses for the availability and acceptability of the groundwater in the area.

## VI. ADVANTAGES AND DISADVANTAGES OF RECOMMENDATIONS

From the economic analysis performed on the Lake Mead surface water treatment facilities, the preferred alternative in each area is developing a groundwater source. This recommendation was based only on engineering and economic factors. Developing a groundwater source has other advantages and disadvantages that are not limited to the following:

### Advantages

- Minimal visual impact
- Easily implemented
- Simplicity of operation
- High degree of reliability
- Low operation & maintenance costs
- No impact on cultural resources
- Minimal natural resource impacts

### Disadvantages

- Retains O & M requirements for wells, disinfection and distribution systems
- Some uncertainty of complete feasibility
- Unknown potential impact from future regulations

In consideration of these additional factors, groundwater source development still appears to be the best alternative for each area. However, the Citizens Utilities option at Katherine would negate the listed disadvantages, making it a virtual toss-up for that area.

## VII. CONCLUSIONS

For each of the six developments studied, it appears that development of a groundwater source is preferred over the other alternatives studied. It is recommended that funding be identified for design and drilling of wells at the earliest opportunity for the five areas excluding Katherine.

For Katherine, although economics favor the groundwater development alternative, present worth costs for Citizens Utilities to purchase and operate the system are close enough to those for groundwater development that other criteria could make it the preferred alternative. It is recommended that management make this determination, and that appropriate follow up action be taken for implementation.

# APPENDICES

# APPENDIX A

## COST BREAKDOWN OF IMPROVEMENTS FOR SWTR COMPLIANCE

(Contingencies not included in prices for items 1 - 12)

1. Utilizing ferric chloride or alum instead of polymer.

| | |
|---|---|
| All sites | $ 0 |

2. Refurbishing and reactivating the flocculator.

| | |
|---|---|
| Boulder Beach | $ 15,000 |
| Callville Bay | $ 15,000 |
| Overton Beach | $15,000 |

3. Construct an in-line static mixer.

| | |
|---|---|
| Echo Bay | $ 4,500 |
| Las Vegas Wash | $ 4,500 |
| Katherine | $ 4,500 |

4. Provide monitoring and sampling equipment.

| | |
|---|---|
| All sites - per site | $ 30,200 |

5. Improvements to the discharge location.

| | |
|---|---|
| Boulder Beach | $ 10,700 |
| Callville Bay | $ 15,100 |
| Echo Bay | $ 20,000 |
| Las Vegas Wash | $ 10,700 |
| Overton Beach | $ 15,100 |
| Katherine | $ 10,700 |

6. Provide additional certification and training for the operators.

| | |
|---|---|
| All sites - per site | $ 6,000 |

7. Provide adequate ventilation exhaust system for the compressed chlorine gas cylinders.

| | |
|---|---|
| All sites - per site | $ 48,000 |

8. Provide an operations plan

| | |
|---|---|
| All sites - per site | $ 35,000 |

9. Provide an emergency chlorine repair kit.

| | |
|---|---|
| All sites - per site | $ 1,600 |

10. Construct an additional filter for redundancy.

| | |
|---|---|
| Callville Bay | $ 110,000 |

11. Filter-to-waste modifications.

| | |
|---|---|
| Boulder Beach | $ 35,000 |
| Callville Bay | $ 34,000 |
| Echo Bay | $ 38,000 |
| Las Vegas Wash | $ 37,000 |
| Overton Beach | $ 35,000 |
| Katherine | $ 36,000 |

12. Perform annual inspection of pressure filters.

| | |
|---|---|
| Las Vegas Wash | $ 5,000 |

FORM D S C - 44

| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet |
|---|---|---|---|
| Area Parkwide | | | of |
| Project Cost for flocculator | By DSPAIN | Checked | Pkg. |
| Feature | Date | Date | Account |

## Construct a flocculator

Assume a 20,000 gallon tank
Class "C" Apr 91 = $85,000
Assume 2 mixers @ 22,500 = $45,000 (Arbor Report)
Assume Electrical $15,000
Assume 120 LF piping @ $22/LF = $2,640

Subt. 147,640

20% for Contingencies 177,160 ≈ $177,200



*U.S. GPO: 1991—576-248

FORM D S C - 44

| Park | AME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet |
|---|---|---|---|---|
| Area | Parkwide | | | of |
| Project | Cost for In-line Mixer | By Wells | Checked | Pkg. |
| Feature | | Date | Date | Account |

## Construct Static In-Line Mixer

Assume Static In-Line Mixer = $2,000

Repiping

Assume 20 Lf @ $22/Lf = $ 440

Controls @ 500 = 500

Assume Labor @ 2 days ($25/hr) =
400 (1.3) = 520

Materials @ = 250

Subtotal = 3,710

Contingencies @ 20% = 742

Total = 4,452

FORM D S C - 44

| Park | CAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet |
|---|---|---|---|---|
| Area | Parkwide | | | of |
| Project | Cost for Sampling / | By | Checked | Pkg. |
| Feature | Monitoring equip | Date | Date | Account |

Provide Flow Monitoring Sampling Turbidimeter and Flow Disinfection

| | | |
|---|---|---|
| Flow Meter @ 2500/ea | | 2500 |
| Controls @ 750/ea | | 750 |
| Labor @ 2 days @ 8hrs @ $25/hr | | - |
| 400 (1.3) | = | 520 |
| Materials @ 250 | | 250 |
| Subtotal Metering | | 4,020 |

Sampling Equipment

| | |
|---|---|
| Assume Sampling Equip @ | 4,000 |
| Controls + Labor as above | 1,395 |
| Subtotal Sampling = | 5,395 |

Turbidimeter

| | |
|---|---|
| Turbidimeter @ | 2,000 |
| Chart Recorder @ | 1,000 |
| Calibration kit @ | 250 |
| Bubble tool @ | 75 |
| Controls @ | 800 |
| Labor @ | 520 |
| Other Materials @ | 300 |
| Subtotal Turbidimeter = | 5,445 |



*U.S. GPO: 1991—576-248

FORM D S C - 44

| Park | CAVE | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet |
|---|---|---|---|---|
| Area | Parkwide | | | of |
| Project | Cost for Samp./Monitor | By | Checked | Pkg. |
| Feature | Equip. (Cont'd) | Date | Date | Account |

Disinfection & Flow Monitoring (Cont'd)

| | | |
|---|---|---|
| As Water Flow Monitoring | = | 4,020 |
| Chlorine Residual Analyzer | = | 3,000 |
| Chart Recorder | = | 1,000 |
| Controls | = | 1,000 |
| Labor 3 days @ 25/hr (1.3 profit) | = | 780 |
| Other Matles | | 500 |
| Subtotal Disinfection | | 10,300 |

| | | |
|---|---|---|
| Subtotal All | = | 25,160 |
| Contingencies @ 20% | = | 5,032 |
| Total | = | 30,192 |

*U.S. GPO: 1991—576-248

FORM D S C · 44

| Park | LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet |
|---|---|---|---|---|
| Area | Overton Beach | | | of |
| Project | Cost for backwash cont | By | Checked | Pkg. |
| Feature | at Overton Beach | Date | Date | Account |

Back Wash Facilities

Overton Beach Enlarge

Existing pond = 20'x30' = 600sf

Pond Required = 1,963 sf

Difference = 1963 - 600 = 1363sf

= 151 $yd^2$

Enlarge lagoon by 151 $yd^2$ $(2.066 \times 10^{-4})$ (1.2)

= 0.048 Acres

Enlarge & improvements - 90,000 (0.048 Acres) = $12,170
to lagoon

Dredge Existing =

$\frac{90,000}{4}$ $\left(\frac{600sf}{9} \times 2.066 \times 10^{-4}\right)$ = 400

Subtotal = 12,570

Contingencies @ 20% = 15,084 $15,100

Overton

FORM D S C - 44

| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet |
|---|---|---|---|
| Area Boulder Beach, Callville Bay | | | of |
| Project Las Vegas Wash Backwash ponds | By | Checked | Pkg. |
| Feature | Date | Date | Account |

## BACKWASH PONDS.

Callville Bay — Enlarge

Same As Overton ⟶ $15,100

## BACKWASH PONDS

### BOULDER BEACH —

Assume 50'ϕ Pond

SF = $\frac{\pi (50)^2}{4}$ = 1,962 sf. = 0.045 acres

Dredge Existing

Modify Class "C"

$\frac{90,000}{4}$/a (0.045 acres) = 1,012

Improvements

Use Class "C" $4/sf (1962) = 7,850

Subtotal = 8,862

Contingencies @ 20% = 10,634 ⇒ Boulder $10,700

Las Vegas Wash

Same as Boulder Beach

Las Vegas $10,700

*U.S. GPO: 1991—576-248

FORM D S C - 44

| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet |
|---|---|---|---|
| Area Echo Bay | | | of |
| Project Backwash pond Calcs | By | Checked | Pkg. |
| Feature for Echo Bay | Date | Date | Account |

Back Wash Ponds Cont'd.

Echo Bay - Const. new Pond.

Assume 50' ϕ Pond

$$\text{Acres} = \left(\frac{(50)^2\ 3.14}{4}\right)\left(\frac{1}{9}\frac{yd^2}{sf}\right)\left(2.066 \times 10^{-4}\frac{acre}{sy}\right)$$

$$= 0.045 \text{ acres}$$

Class "C" - Construct lagoon & improvements = $\frac{\$90{,}000}{acre}$ (0.045 acres)

= $11,905

Assume 200 lf of 6" DIP Piping

Class "C" 200 lf ($22/lf) = $4,400

Subtotal = $16,305

Contingencies @ 20% = 19,566 ⇒ $20,000

Echo



*U.S. GPO: 1991—576-248

FORM D S C - 44

| Park | Lame | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet |
|---|---|---|---|---|
| Area | Katherine | | | of |
| Project | Back wash Pond calcs | By | Checked | Pkg. |
| Feature | for Katherine | Date | Date | Account |

## Provide Adequate Backwash Disposal Site

Katherine – No Change – just dredge

Assume size = 50'ϕ, 3' deep

$ft^2 = \frac{\pi d^2}{4} = \frac{\pi (50)^2}{4} = 1{,}963\ ft^2 = 218\ yd^2$

Acres = $2.066 \times 10^{-4}$ (218) = 0.045 acres

Harpoon w/Construct = $4/sf = Using 50 ft ϕ
$4/sf (1963 sf) $7,850

Dredg. Existing. Assume 1/4 of Class "C"
for Dredging
$\frac{\$10{,}000}{4}$/acre (0.045 acres) = $1,013

Subtotal = 8,863

20% Contingencies = 10,636

Katherine
$ 10,700

FORM D S C - 44

| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet |
|---|---|---|---|
| Area Parkwide | | | of |
| Project Cost Estimate for | By | Checked | Pkg. |
| Feature Exhaust System & Repair Kit | Date | Date | Account |

Chlorine Exhaust & Scrubber System

Assume Systems are 1/3 size of Presidio which is estimated @ 120,000

40,000 — 40,000

20% Contingencies = 8,000

Total = 48,000

Provide Emergency Chlorine Repair kit

Assume Equipment @ $1,000

Labor 1 day @ 25/hr (1.3 profit) = 260

1,260

Contingencies @ 20% = 1,512 — $1600

FORM D S C - 44

| Park | LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet |
|---|---|---|---|---|
| Area | Park Wide | | | of |
| Project | Filter - to - Waste | By | Checked | Pkg. |
| Feature | costs for each site | Date | Date | Account |

## Filter - to - Waste

### Boulder Beach

50 LF @ $30 = $1500

3 - 6" valves @ 3000/ea = 9,000

Controls - 20,000

30,500 + 15% Contingencies ≈ $35,000

### Callville Bay

100 LF @ 30/LF = $3,000

2 - 6" Valves @ 3000 = 6,000

Controls 20,000

29,000 + 15% Contingencies ≈ $34,000

### Echo Bay

120 LF @ $30/LF = 3600

2 valves = 9,000

Controls 20,000

32,600 + 15% Contingencies ≈ $38,000

### Las Vegas Wash

100 LF @ 30/LF = 3000

3 valves = 9000

Controls = 20,000

32,000 + 15% Contingencies ≈ $37,000

☆ U.S. GPO: 1990—776-586

FORM D S C - 44

| Park | Lame | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet |
|---|---|---|---|---|
| Area | Parkwide | | | of |
| Project | Filter-to-Waste | By | Checked | Pkg. |
| Feature | Culcs for each site | Date | Date | Account |

Filter-to-Waste - Cost Estimates

Overton Beach

50 LF @ $30/LF = $1500
3 Valves @ 3000/ea = 9000
Controls = 20,000
$30,500 + 15% Contingencies ≈ 35,000

Katherine

75 LF @ $30/LF = 2250
3 valves @ 3000/ea = 9000
Controls = 20,000
$31,250 + 15% Contingencies ≈ 36,000

# APPENDIX B

## COST BREAKDOWN FOR EACH ALTERNATIVE

### A. CONNECTING TO A MUNICIPALITY

These present worth values include O & M, monthly charges, and contingencies. They do not include any demolition or site restoration for the existing treatment plant facilities.

| | | |
|---|---|---|
| 1. | Boulder Beach | $3,400,000 |
| 2. | Las Vegas Wash | $1,900,000 |
| 3. | Katherine | $1,200,000 |

### B. DRILLING WELLS

These costs are per well. Each site will require two wells to create redundancy. These values do not include contingencies, nor demolition or site restoration for the existing treatment plant facilities.

| | | |
|---|---|---|
| 1. | Engineering design | $ 4,500 |
| 2 | Engineering investigation/field | $ 18,000 |
| 3. | Drilling/developing well | $ 26,000 |
| 4. | Well building/disinfection equipment | $ 50,800 |
| 5. | Well pump/equipment and labor | $ 9,000 |
| 6. | Piping and appurtenances for connection of well to the existing distribution system | $ 10,500 |

### C. COST ANALYSIS OF ADDITIONAL IMPROVEMENTS RECOMMENDED FOR PLANT UPGRADE.

These values do not include contingencies.

1. Boulder Beach
   a. Connect the visitor center to Boulder City's water system $ 70,000
   b. Construct comfort facility including lavatory and shower $ 62,500

| | | | |
|---|---|---|---|
| | c. | Construct a 10-inch isolation valve | $ 3,600 |
| | d. | Repair of filter underdrains and add provisions for surface wash and/or air scour | $ 40,000 |
| | e. | Improvements to the climate control equipment | $ 1,000 |
| | f. | Annual operations and maintenance cost | $ 130,800 |
| 2. | Callville Bay | | |
| | a. | Construct a 80,000 gallon water storage tank | $ 160,000 |
| | b. | Replace/rehab of the intake barge | $ 85,000 |
| | c. | Construct comfort facilities | $ 62,500 |
| | d. | Enclose laboratory | $ 2,900 |
| | e. | Provide a PLC and personal computer for remote control and has alarms | $ 2,500 |
| | f. | Improvements to the climate control equipment | $ 1,000 |
| | g. | Relocate fill pipe to top of tank | $ 1,000 |
| | h. | Annual operations and maintenance cost | $ 88,800 |
| 3. | Echo Bay | | |
| | a. | Replace intake barge | $ 85,000 |
| | b. | Construction of a new package plant with dual filtration capabilities, buildings and appurtenances included in the cost | $ 250,000 |
| | c. | Construction of a new water tank and water lines | $ 425,000 |
| | d. | Annual operations and maintenance cost | $ 135,400 |
| 4. | Las Vegas Wash | | |
| | a. | Construct a 110,000 gallon water tank | $ 186,000 |
| | b. | Improvements to the climate control equipment | $ 1,000 |
| | c. | Construct comfort facilities | $ 62,500 |
| | d. | Construct enclosure for laboratory | $ 2,900 |
| | e. | Piping modifications to use treated water for chlorine solution make up water | $ 8,000 |
| | f. | Annual operations and maintenance cost | $ 115,100 |
| 5. | Overton Beach | | |
| | a. | Construct enclosure for the existing treatment plant | $ 66,150 |
| | b. | Improvements to the climate control equipment | $ 1,000 |
| | c. | Annual operations and maintenance cost | $ 139,600 |

6. Katherine

| | | |
|---|---|---|
| a. | Construct comfort facilities | $ 62,500 |
| b. | Construct laboratory enclosure | $ 2,900 |
| c. | Replace/rehab of the intake barge | $ 85,000 |
| d. | Installation of a fire hydrant for the maintenance facility | $ 16,000 |
| e. | Separation of supply line from treatment plant to water storage tank | $ 75,000 |
| f. | Annual operations and maintenance cost | $ 144,200 |

FORM D S C - 44

| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 1 |
|---|---|---|---|
| Area BOULDER BEACH | | | of 4 |
| Project Municipality Connection | By D'Spain | Checked | Pkg. |
| Feature Costs | Date 3/9/93 | Date | Account |

## Pressure Reducing Structure & Appurtenances

| Quantity | Item Descr. | Unit Cost | Total |
|---|---|---|---|
| 2 | 8" Gate Valve & Box | $950/ea | 1,900 |
| 1 | 8" Water Meter | 14,000/ea | 14,000 |
| 1 | RTU & 8" Butterfly Valve | | 3,200 |
| | RTU includes: | | |
| | 5100 LF of cable | $17/LF | 86,700 |
| | Control Panel | $1000/ea | 1,000 |
| 2 | Pressure Gauge | $250/ea | 500 |
| 1 | 8" Pressure Reducing Valve | $5000/ea | 5,000 |
| 1 | Drain Valve | $3500/ea | 3,500 |
| 1 | Concrete Structure 33 CY | $1000/CY | 33,000 |
| | 210 LF of 8" DIP | $36/LF | 7,560 |
| | | | 156,360 |
| | | +20% Contingency | 31,272 |
| | | | $187,632 |

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FORM D S C - 44

| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 2 |
|---|---|---|---|
| Area Boulder Beach | | | of 4 |
| Project Municipality Connection | By D'SPAIN | Checked | Pkg. |
| Feature Costs | Date 3/9/93 | Date | Account |

Monthly Charges — Annual Costs

Meter Fee $1000/mo x 12 mo/yr — $12,000

Charge for Water

Monthly usage (ave.) = 450,000 gpd

Boulder City charge = $2/1000 gallons

Annual Expense

$450{,}000 \text{ gallon/day} \times 365 \text{ day/yr} \times \$2/1000 \text{ gall} = \$328{,}500$

$340,500

$PW_{mc} = (P/A, 10\%, 20) = 8.514$

Present Worth of Monthly Charges

$PW_{mc} = 340{,}500\ (8.514) = \$2{,}899{,}017$

FORM D S C - 44

| | | | | |
|---|---|---|---|---|
| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | | Sheet 3 |
| Area Boulder Beach | | | | of 4 |
| Project Municipality Connection | By D'SPAIN | | Checked | Pkg. |
| Feature Costs | Date 3/9/93 | | Date | Account |

O & M Costs

Assuming 15% of the present O & M costs for the distribution system & Storage

Boulder Beach present Annual O & M cost
#130,800

15% of #130,800 = #19,620 Annually

Present Worth Value for Annual O & M

PW = (P/A, 10%, 20) = 8.514

$PW_{om}$ = 19,620 (8.514) = #167,044

FORM D S C - 44

| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 4 |
|---|---|---|---|
| Area Boulder Beach | | | of 4 |
| Project Municipality Connection | By DSpain | Checked | Pkg. |
| Feature Costs | Date 3/9/93 | Date | Account |

Total Present Worth Value for the connection to Boulder City

Capital Construction Costs

Net Construction = $187,632

Gross Construction includes
31% for project supervision & other contingencies of Net Construction
187,632 × 1.31 = 245,797 = Gross Contruction

Design Cost = 25% of Gross Construction
245,797 x(.25) = $61,449 = Design Costs

Total = 245,797 + 61449 = $307,246

Total Present Worth Value for the Boulder Beach to Boulder City Connection (Pg 4)

$PW_T$ = $307,246 + 167,044 + 2,899,017 = 3,373,307 (Pg 3, Pg 2)

≅ 3,400,000 →

FORM D S C - 44

| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 1 |
|---|---|---|---|
| Area Las Vegas Wash | | | of 4 |
| Project Connection to City of Henderson | By D'SPAIN | Checked | Pkg. |
| Feature | Date 3/9/93 | Date | Account |

## Capital Construction Costs

| Quantity | Item | Unit Cost | Total |
|---|---|---|---|
| 12,300 LF | 6" DIP | $30/LF | $369,000 |
| 1 | 6" water meter & box | $8,500/ea | 8,500 |
| 14 | 6" gate Valve | $750/ea | $10,500 |
| 1 | Pressure reducing Valve | $5,000/ea | 5,000 |
| 6 | Pressure Relief Valves | $3,700/ea | 22,200 |
| | | | 415,200 |
| | | Plus 20% contng. | 83,040 |
| | | | $498,240 |

(see Sht 4 of this set for Gross Const & Design Costs)

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FORM D S C - 44

| | | | | |
|---|---|---|---|---|
| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | | Sheet 2 |
| Area Las Vegas Wash | | | | of 4 |
| Project Connection to City of Henderson | By D'Spain | | Checked | Pkg. |
| Feature | Date 3/9/93 | | Date | Account |

Monthly Charges — Annual Cost

Meter fee $1000/mo x 12 mo/yr — $12,000

Charge for water

- Monthly usage (Ave) = 90,000 gpd
- City of Henderson water charge - $2/1000 gal.

Annual cost of water:

$$90{,}000 \text{ gal/day} \times 365 \text{ day/yr} \times \$2/1000 \text{ gal} = \$65{,}700$$

$77,700

Present Worth value for Monthly Charges

$PW_{mc} = (P/A, 10\%, 20) = 8.514$

$PW_{mc} = (77{,}700)\ 8.514 = 661{,}537.8$

FORM D S C · 44

| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 3 |
|---|---|---|---|
| Area Las Vegas Wash | | | of 4 |
| Project Connection to Cty of Henderson | By D'Spain | Checked | Pkg. |
| Feature | Date 3/9/93 | Date | Account |

## Operations & Maintenance Costs (O&M)

Present Annual O&M cost = $115,100

O&M charges for maintaining storage & a distribution system will be assume to be 15% of present O&M costs.

(.15)(115,100) = $17,265

Annual O&M for this connection Alternative = $17,265

## Present Worth value for O&M Cost

$PW_{om} = (P/A, 10\%, 20) = 8.514$

$PW_{om} = (17,265)(8.514) = \$146,994$

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FORM D S C - 44

| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 4 |
|---|---|---|---|
| Area Las Vegas Wash | | | of 4 |
| Project Connection to City of Henderson | By D'SPAIN | Checked | Pkg. |
| Feature | Date 3/9/93 | Date | Account |

Net Construction = $498,240

Gross Const = Net construction plus 31% of Net

= ($498,240)(1.31) = $652694

Design Costs = 25% of Gross Construction

= 652,694 x .25 = $163,173.60

Total Construction Costs = $652,694 + $163,173.60

= #815,868

Additional Charges

Lake Las Vegas Development will charge $261,579 to make improvements to their system for the Park to connect.

Present Worth Value for the City of Henderson Connection

Const Cost / PWmc / PWom / Add'l Cost

PW = 815,868 + 661,538 + 146,994 + 261,579 = $1,885,979

(Pg. 2) (Pg. 3)

≅ $1,900,000

FORM D S C - 44

| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 1 |
|---|---|---|---|
| Area Katherine | | | of 1 |
| Project The purchase of the infastructure | By DSPAIW | Checked | Pkg. |
| Feature | Date 3/9/93 | Date | Account |

## Capitol Construction Costs

Citizens Utilities of Bullhead, Ariz offered a preliminary price of $160,000 for the purchase of Katherine's Treatment Plant & Distribution system

($160,000)

## Monthly Charges

Citizens Utilities stated that they would charge $1.48/1000 gal for water

monthly usage (ave.) = 290,000 gpd

## Annual Expense for Water

$290{,}000 \text{ gal/day} \times 365 \text{ day/yr} \times \$1.48/1000 \text{ gal} = \$156{,}658$

$PW_{mc} = 156.658\ (8.514) = \$1{,}333{,}786$

## Present Worth Value for selling Katherine's infrastructure:

Using $PW = (P/A, 10\%, 20) = 8.514$

$PW = (-160{,}000) + 156{,}658\ (8.514) = \$1{,}173{,}786$

$\$1{,}200{,}000$ ⟹

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FORM D S C - 44

| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 1 |
|---|---|---|---|
| Area PARKWIDE | | | of 2 |
| Project COST FOR DEVELOPING | By D'SPAIN | Checked | Pkg. |
| Feature A 10" WELL | Date 10/27/92 | Date | Account |

## Construction Costs for Developing 10" Well

Assume: 200' well

Cost per foot = ($65/LF x 2 Eng. factor) = $130/LF

| Item | Per well | Per site |
|---|---|---|
| Engineering cost | $4500 | $9,000 |
| Engineering Design | $18,000 | $36,000 |
| Drilling (200 LF x $130/LF) | $26,000 | $52,000 |
| Building & Chlorination (A=290 SF) (290 SF x $175/SF) | $50,800 | $101,600 |
| Well pump equipment & labor | $9,000 | $18,000 |
| Piping from well to storage (700 LF x $30/LF) | $10,500 | $21,000 |
| | | $237,600 |
| 15% Contingencies | | 35,640 |
| | | $273,240 |

Net Construction Cost = $273,240

Gross Construction Cost: Net Const Cost plus 31% (for proj Supr)

= 273,240 x 1.31

Gross Construction Cost = $357,944.40 ≅ (360,000)

Design Cost = 20% of Gross Construction Cost

= 357,944.40 x .20

Design Cost = $71,588.88 ≅ (70,000)

Total Const Cost = $357,944.40 + 71,588.88 = $429,533.28

FORM D S C - 44

| Park | LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 2 |
|---|---|---|---|---|
| Area | Parkwide | | | of 2 |
| Project | Cost for developing a | By DSPOIN | Checked | Pkg. |
| Feature | 10" well | Date 10/27/92 | Date | Account |

## Operation & Maintenance Cost for Wells

Annual Cost = $70,000 (taken from O&M costs for existing wells in the park)

Present Worth Value for O & M costs for wells

$PW_{om} = (P/A, 10\%, 20) = 8.514$

$PW_{om} = (70,000)8.514 = \$595,980 \doteq (600,000)$

## Total Present Worth value for developing a 10" Well

$PW_T$ = Const. Cost + $PW_{om}$

$= \pm 429,533.28 + \$595,980$

$= \pm 1,025,513.28$

$\doteq \$1,000,000$

FORM D S C - 44

| | | | |
|---|---|---|---|
| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 1 |
| Area Boulder Beach | | | of 3 |
| Project SWTR Compliance Cost | By DSpain | Checked | Pkg. |
| Feature | Date 10/27/92 | Date | Account |

## SWTR Compliance Improvements Required

Useful life = 20 yrs
Interest = 10%

| SWTR Improvements | Cost |
|---|---|
| Primary Coagulant | - 0 - |
| Refurbish / Reactivate flocculator | $15,000 |
| Monitoring / Sampling Equipment | $30,200 |
| Disposal Site | $10,700 |
| Certification / Training Personnel | $ 6,000 |
| Operations Plan | $35,000 |
| Exhaust System for Chlorine Gas | 48,000 |
| Chlorine Repair Kit | 1,600 |
| filter - to - Waste | 35,000 |
| | $181,500 |
| Plus 20% Conting | 36,300 |
| | $217,800 |

Net Const Cost = $217,800

Gross Const = Net Const plus 31%
= 217,800 x 1.31

Gross Const. = $285,318 ≅ (290,000)

Design Cost = 25% of Gross Const = $285,318 x .25

Design Cost = $71,329.5 ≅ (70,000)

Total Const Cost = $285,318 + 71329.5 = $356,647.5 (SWTR)

FORM D S C - 44

| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 2 |
|---|---|---|---|
| Area Boulder Beach | | | of 3 |
| Project Additional Impr. Costs | By D'Espain | Checked | Pkg. |
| Feature | Date 10/27/92 | Date | Account |

## Additional Improvements not required for SDTR

| Additional Improvements | Cost |
|---|---|
| Connect Visitor Center to Boulder City Wa. System | $ 70,000 |
| Construct Comfort facilities | $ 62,500 |
| Construct 10" isolation Valve | 3,600 |
| Repair underdrains & add provisions for surface wash &/or air scour | $ 40,000 |
| Improvements to climate Control Equip | $ 1,000 |
| | $ 177,100 |
| Plus 20% Contingency | 35,420 |
| | $ 212,520 |

Net Const Cost = $ 212,520

Gross Const = Net Const plus 31%

= 212,520 x 1.31

= $ 278,401.20

Design Cost = 25% of Gross Const.

= .25 (278,401.20)

= 69,600.30

Total Const. Cost = 278,401.20 + $ 69,600.30

= $ 348,001.50

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FORM D S C - 44

| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 3 |
|---|---|---|---|
| Area Boulder Beach | | | of 3 |
| Project O & M costs for SWTR | By D'Spain | Checked | Pkg. |
| Feature & Add'l improv. | Date 10/27/92 | Date | Account |

## O & M Costs for Boulder Beach

Annually Cost = $130,800

Present Worth Value for O & M cost

$PW_{om} = (P/A, 10\%, 20) = 8.514$

$= 130,800\ (8.514)$

$PW_{om} = \$1,113,631.20 \cong (1,110,000)$

## Total Present Worth Value for SWTR improvement & O+M

$PW_{T_1} = 356,647.5 + 1,113,631.20$

$PW_{T_1} = \$1,470,278.7 \cong (\$1,500,000)$

## Total Present Worth value for SWTR & Add'l Improvements plus O & M

$PW_{T_2} = \$356,647.5 + \$348,001.50 + \$1,113,631.20$

$= \$1,818,280.20 \cong (1,800,000)$

FORM D S C - 44

| Park CAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 1 |
|---|---|---|---|
| Area Calliville Bay | | | of 3 |
| Project SWTR Compl Improvements | By D'Spain | Checked | Pkg. |
| Feature | Date 10/27/92 | Date | Account |

# SWTR Compliance Improvements Required

| SWTR Improvements | Cost |
|---|---|
| Primary Coagulant | -0- |
| Refurbish/Reactivate flocculator | 15,000 |
| Sampling/Monitoring Equip. | 30,200 |
| Disposal/backwash pond | 15,100 |
| Certification/Training personnel | 6,000 |
| Operations Plan | 35,000 |
| Exhaust system for chlorine gas | 48,000 |
| Chlorine Repair kit | 1,600 |
| Additional filter | 110,000 |
| filter-to-waste improv. | 34,000 |
| | $ 294,900 |
| Plus 20% for Contingc. | 58,980 |
| | $ 353,880 |

Net Const = $ 353,880

Gross Const = Net Const + 31%

= 353,880 × 1.31

= 463,582.80 ≅ ($ 460,000)

Design Cost = 25% of Gross Const

= .25 (463,582.80)

= $ 115,895.70 ≅ (120,000)

Total Const Cost = $ 463,582.80 + $ 115,895.70 = $ 579,478.5

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FORM D S C - 44

| Park CAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 2 |
|---|---|---|---|
| Area Calluville Bay | | | of 3 |
| Project Add'l Improv. Costs | By D'Spain | Checked | Pkg. |
| Feature | Date 10/27/82 | Date | Account |

Additional Improvements not required for SWTR

| Additional Improvements | Cost |
|---|---|
| Comfort facility | $62,500 |
| Enclose Lab | 2,900 |
| Telephone Dialer | 2,500 |
| Climate Control Equip | 1,000 |
| Relocate fill pipe | 1,000 |
| Rehab. intake barge | 85,000 |
| 80,000 gallon storage tank | 160,000 |
| | $314,900 |
| Plus 20% for Contingencies | 62,980 |
| | $377,880 |

Net Const = $377,880

Gross Const = Net Const plus 31%

= 377,880 x 1.31

= 495,022.80 ≅ (490,000)

Design Cost = 25% of Gross Const

= .25 (495,022.80)

= $123,755.70 ≅ (120,000)

Total Const. Cost = 495,022.80 + 123,755.70

= $618,778.50

FORM D S C - 44

| Park CAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 3 |
|---|---|---|---|
| Area Colville Bay | | | of 3 |
| Project O & M Costs | By DSpain | Checked | Pkg. |
| Feature | Date 10/27/92 | Date | Account |

O & M Costs for Colville Bay

Annual Cost = $88,800

Present Worth Value for O & M

$PW_{om} = (P/A, 10\%, 20) = 8.514$

$PW_{om} = 88,800\ (8.514)$

$= \$756,043.20$

Total Present Worth Value for SWTR improv. & O&M costs

$PW_T = \$579,478.50 + 756,043.20$

$= \$1,335,521.7 \cong (\$1,300,000)$

Total Present Worth Value for SWTR & Add'l improv. plus O&M costs

$PW_{12} = \$579,478.50 + 618,778.50 + \$756,043.20$

$= \$1,954,300.20 \cong (\$2,000,000)$

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FORM D S C - 44

| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 1 |
|---|---|---|---|
| Area Echo Bay | | | of 4 |
| Project SWTR Compl. Improv | By D'Espain | Checked | Pkg. |
| Feature | Date 10/27/92 | Date | Account |

## SWTR Compliance Improvements Required

| SWTR Improvements | Costs |
|---|---|
| Primary Coagulant | -0- |
| Monitoring / Sampling Equip. | $30,200 |
| Disposal / backwash pond | 20,000 |
| Certification / Training of Personnel | 6,000 |
| Operations Plan | 35,000 |
| Exhaust System for Chlorine Gas | 48,000 |
| Chlorine Repair Kit | 1,600 |
| filter-to-waste improvements | 38,000 |
| Subtotal | $178,800 |

* The existing treatment plant useful life = 5 yrs therefore we will add in a new treatment plant in 5 yrs A new plant costs - $250,000
present value = (P/F, 10%, 5) = .6209
Present value of a new plant that will cost $250,000 in 5 yrs is:

P = 250,000 (.6209) = $155,225

Net Const (if only SWTR compl improv are done)
= 334,825 plus 20%
= 400,830

Net Const (if SWTR are done w/ the Add'l imp)
= 178,800 plus 20%
= $214,560

FORM D S C - 44

| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 2 |
|---|---|---|---|
| Area Echo Bay | | | of 4 |
| Project SWTR Compliance | By D'Spain | Checked | Pkg. |
| Feature Costs | Date 10/27/92 | Date | Account |

SWTR Compliance Improvements Required (Cont'd)

Costs for SWTR improv only (not including O+M)

Gross Const. Cost = Net const plus 31%

$= \$400,830 \times 1.31$

$= \$525,087.30 \cong (\$530,000)$

Design Cost = 25% of Gross Const.

$= .25 (\$525,087.30)$

$= 131,271.83 \cong (\$130,000)$

Total Const Cost = $525,087.30 + 131,271.83 = \$656,359.13$

Costs for SWTR if Add'l improv. are done also
(excluding O&M costs)

Gross Const Cost = Net const plus 31%

$= 214,560 \times 1.31$

$= \$281,073.60$

Design Cost = 25% of Gross Const

$= .25 (281,073.60)$

$= \$70,268.40$

Total Cost = $281,073.60 + 70,268.40 = \$351,342$

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FORM D S C - 44

| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 3 |
|---|---|---|---|
| Area Echo Bay | | | of 4 |
| Project Add'l Improvement Cost | By DEpair | Checked | Pkg. |
| Feature | Date 10/27/92 | Date | Account |

## Additional Improvements not required by SWTR

| Additional Improvements | Cost |
|---|---|
| Replace intake Barge | $85,000 |
| New water lines & tank | 425,000 |
| * New Package Plant (dual-filters) | 250,000 |
| | $760,000 |
| plus 20% Contingency | 152,000 |
| | $912,000 |

Net Construction = $912,000

Gross Construct = Net Const plus 31%

= 912,000 x 1.31

= $1,194,720 ≅ (1,200,000)

* This is the value of Add'l improvements are done along with SWTR improv. since the Package Plant was added in SWTR Improv. Separately

Design Cost = 25% of Gross

= .25 (1,194,720)

= $298,680

Total Const. Cost = 298,680 + 1,194,720 = 1,493,400

* IF the Package Plant is planned to be done w/ the SWTR improvements

Net Const = ($760,000 - 250,000) .20 Contig = $612,000

Gross Const = $612,000 x 1.31 = 801,720 ≅ ($800,000)

Design Cost = 801,720 x .25 = 200,430 ≅ ($200,000)

Total Cost = $801,720 + $200,430 = $1,002,150

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FORM D S C - 44

| Park LAKE | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 4 |
|---|---|---|---|
| Area Echo Bay | | | of 4 |
| Project O & M Costs | By D[illegible] | Checked | Pkg. |
| Feature | Date 10 [illegible] 19[illegible] | Date | Account |

## O & M Costs for Echo Bay

Annual Cost = $135,415

Present Worth Value for O&M

$PW_{om} = (P/A, 10\%, 20) = 8.514$

$= \$135,415 (8.514)$

$= \$1,152,923 \cong (\$1,150,000)$

## Total Present Worth Value for SWTR imp. & O & M

$PW_T = 656,359.13 + 1,152,923$

$= \$1,809,282.13 \cong (\$1,810,000)$

## Total Present Worth Value for SWTR & Add'l rmprov plus O & M

$PW_{T_2} = \$351,342 + 1,493,400 + 1,152,923$

$= 2,997,665 \cong (3,000,000)$

Gross Const Cost for Add'l improv. when doing SWTR also

$= 1,194,720 + 281,073.60 - 525,087 = \$950,706$ **

Design Cost for Add'l imp. (only)

$= 298,680 + 70,268 - 131,271.83 = \$237,677 \cong \$240,000$ *

☆ U.S. GPO: 1990—776-586

FORM D S C - 44

| Park LAMS | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 1 |
|---|---|---|---|
| Area Los Vegas Dist | | | of 3 |
| Project SWTR impvt. Costs | By DSpair | Checked | Pkg. |
| Feature | Date 3-7-92 | Date | Account |

## SWTR Compliance Improvements Required

| SWTR Improvements | Cost |
|---|---|
| Primary Coagulant | -0- |
| Static Mixer | $ 4,500 |
| Monitoring/Sampling Equip | 30,200 |
| Annual inspections $5000 (8.514) | 42,570 |
| Backwash pond | 10,700 |
| Certification/Training of Personnel | 6,000 |
| Operations Plan | 35,000 |
| Exhaust System for Chlorine Gas | 48,000 |
| Chlorine Repair Kit | 1,600 |
| filter-to-waste improv. | 37,000 |
| | 215,570 |
| plus 20% for Cont'g. | 43,114 |
| | $ 258,684 |

Net Const. = $258,684

Gross Const = Net plus 31%

= 258,684 x 1.31

= $338,876 ≅ (340,000)

Design Cost = 25% of Gross Const

= .25(338,876)

= $84719 ≅ ($80,000)

Total Const Cost = 338,876 + 84719

= $423,595

FORM D S C - 44

| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 2 |
|---|---|---|---|
| Area Las Vegas Wash | | | of 3 |
| Project Add'l impvt. Cost | By D'Spain | Checked | Pkg. |
| Feature | Date 10/27/92 | Date | Account |

## Additional Improvements not required by SWTR

| Additional Improvements | Cost |
|---|---|
| 100,000 gallon storage tank | $186,000 |
| Climate Control Equip | 1,000 |
| Comfort facility | 62,500 |
| Closure for laboratory | 2900 |
| Piping Modification for disinfect. | 8,000 |
| | $260,400 |
| Plus 20% for Contng. | 52,080 |
| | $312,480 |

Net Const Cost = $312,480

Gross Const. Cost = Net Const plus 31%

= 312,480 x 1.31

= $409,348.8 → ≅ (410,000)

Design Cost = 25% of Gross Const

= .25 (409,348.8)

= 102,337.20 → ≅ ($100,000)

Total Cost = 409,348.8 + 102,337.20

= $511,686 ≅ ($510,000)

FORM D S C - 44

| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 3 |
|---|---|---|---|
| Area Las Vegas Wash | | | of 3 |
| Project O & M costs & | By D'Espain | Checked | Pkg. |
| Feature total Present Worth | Date 10/27/03 | Date | Account |

## O & M costs for Las Vegas Wash

Annual cost = $115,100

Present Worth value for O & M

$PW_{om} = (P/A, 10\%, 20) = 8.514$

$= 115,100 (8.514)$

$PW_{om} = \$979,961 \cong (\$980,000)$

## Total Present Worth value for SWTR improv. & O & M.

$PW_{T_1} = 423,595 + 979,961$

$= 1,403,556 \cong (\$1,400,000)$

## Total Present Worth value for SWTR & Add'l improv. plus O & M

$PW_{T_2} = \$423,595 + \$511,686 + 979,961$

$= \$1,915,242 \cong (\$1,910,000)$

FORM D S C - 44

| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 1 |
|---|---|---|---|
| Area Overton Beach | | | of 3 |
| Project SWTR impror. Costs | By DiSpain | Checked | Pkg. |
| Feature | Date 10/27/92 | Date | Account |

# SWTR Compliance Improvements Required

| SWTR Improvements | Cost |
|---|---|
| Primary Coagulant | -0- |
| Refurbish / Reactivate flocculator | $ 15,000 |
| Monitoring / Sampling Equip. | 30,200 |
| Backwash pond | 15,100 |
| Certification / Training for personnel | 6,000 |
| Operations Plan | 35,000 |
| Exhaust System for chlorine | 48,000 |
| Chlorine Repair kit | 1,600 |
| filter-to-waste impror. | 35,000 |
| | $ 185,900 |
| Plus 20% Contng. | 37,180 |
| | $ 223,080 |

Net Const. = $ 223,080

Gross Const = Net plus 31%

= 223,080 x 1.31

= 292,234 ≅ ($ 290,000)

Design Cost = 25% of Gross Const.

= .25 (292,234)

= $ 73,058 ≅ ($ 70,000)

Total Const. Cost = 292,234 + 73,058

= $ 365,292

*U.S. GPO: 1991—576-248

FORM D S C - 44

| Park LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 2 |
|---|---|---|---|
| Area Overton Beach | | | of 3 |
| Project Add'l Improv. Cost | By DiSpain | Checked | Pkg. |
| Feature | Date 15 Jan 92 | Date | Account |

## Additional Improvements not required by SWTR

| Additional Improvements | Cost |
|---|---|
| Enclosure for plant | $66,150 |
| Climate Control Equip | 1,000 |
| | $67,150 |
| Plus 20% for Contins: | 13,430 |
| | $80,580 |

Net Const Cost = $80,580

Gross Const Cost = Net Const plus 31%

= 80,580 x 1.31

= 105,559 ≅ ($110,000)

Design Cost = 25% of Gross Const-

= .25 (105,559)

= $26,389 ≅ (30,000)

Total Const Cost = $105,559 + $26,389

= $131,948

FORM D S C - 44

| Park | LAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 3 |
|---|---|---|---|---|
| Area | Overton Beach | | | of 3 |
| Project | O & M costs & | By Despain | Checked | Pkg. |
| Feature | total Present Worth Value | Date 6/27/92 | Date | Account |

## O & M costs for Overton Beach

Annual Cost = $139,621

Present Worth Value for O&M

$PW_{om} = (P/A, 10\%, 20) = 8.514$

$PW_{om} = 139,621\ (8.514)$

$= \$1,188,733 \rightarrow \cong (\$1,190,000)$

## Total Present Worth value for SWTR improv plus O&M

$PW_{T_1} = 365,292 + 1,188,733$

$= \$1,554,025 \rightarrow \cong (\$1,550,000)$

## Total Present Worth Value for SWTR & Add'l Improv plus O&M

$PW_{T_2} = \$365,292 + \$131,948 + \$1,188,733$

$= \$1,685,973 \rightarrow \cong (\$1,690,000)$

FORM D S C - 44

| Park | Lome | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet 1 |
|---|---|---|---|---|
| Area | Katherine | | | of 3 |
| Project | SWTR impvt. Cost | By D'Spain | Checked | Pkg. |
| Feature | | Date 10/27/92 | Date | Account |

## SWTR Compliance Improvements Required

SWTR Improvements — Cost

Arizona has not mandated Compliance with the SWTR as of yet, therefore an assumed value of Construction will be →

180,000
180,000
Plus 20% for Contingency 36,000
$216,000

Net Construction Cost = $216,000

Gross Construct = Net Const plus 31%

= 216,000 x 1.31

= $282,960 ≅ (280,000)

Design Cost = 25% of Gross Const

= .25 (282,960)

= $70,740 ≅ ($70,000)

Total Construction Cost for SWTR improv.

= 282,960 + 70,740

= $353,700

FORM D S C - 44

| Park | CAME | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet | 2 |
|---|---|---|---|---|---|
| Area | Katherine | | | of | 3 |
| Project | Add'l impr. Cost | By | D'Spain | Checked | Pkg. |
| Feature | | Date | 10/27/92 | Date | Account |

Additional Improvements not required for SWTR

| Additional Improvements | Cost |
|---|---|
| Comfort facilities | $62,500 |
| Enclose Lab | 2,900 |
| Rehab intake Barge | 85,000 |
| Separating Supply line | 75,000 |
| Installation of fire hydrant | 16,000 |
| | $241,400 |
| Plus 20% Contingency ✓ | 48,280 |
| | $289,680 |

Net Const Cost = $289,680

Gross Construct = Net plus 31%

= 289,680 x 1.31

= $379,480.80 ≅ ($380,000)

Design Cost = 25% of Gross Const.

= .25(379,480)

= $94,870 ≅ ($90,000)

Total Const Cost = 379,480 + 94,870

= 474,350

FORM D S C - 44

| Park | Lame | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet | 3 |
|---|---|---|---|---|---|
| Area | Katherine | | | of | 3 |
| Project | O&M Cost & Present | By | D'Spain | Checked | Pkg. |
| Feature | Worth totals | Date | 10/27/92 | Date | Account |

## O & M costs for Katherine

Annual Cost = $144,162

Present Worth value of O&M

$PW_{om.} = (P/A, 10\%, 20) = 8.514$

$= 144,162\ (8.514)$

$= 1,227,395 \Rightarrow \simeq (\$1,230,000)$

## Total Present Worth value for SWTR improv. & O&M

$PW_{T_1} = 353,700 + 1,227,395$

$= \$1,581,095 \simeq (\$1,580,000)$

## Total Present Worth value for SWTR & Add'l improv. & O&M

$PW_{T_2} = 474,350 + 353,700 + 1,227,395$

$= \$2,055,445 \simeq (\$2,050,000)$

FORM D S C - 44

| Park | CAME | NATIONAL PARK SERVICE<br>DENVER SERVICE CENTER | | Sheet |
|---|---|---|---|---|
| Area | Boulder Beach | | | of |
| Project | Add'l improvement | By | Checked | Pkg. |
| Feature | Cost | Date | Date | Account |

COST ESTIMATE FOR ADDITIONAL IMPROVEMENTS

Boulder Beach

Comfort Facilities

Using Class "C" April 1991

400 sf - 100,000 but Assume 250 sf 62,500

100,000 ( 250/400 ) =

10" Isolation Valve

Valve - Assume 2500

Backhoe 1/2 day 500

Labor 8hrs ( 30/hr) 240

3,240 x 1.10 3,600

Construct Storage Tank Canopy

Dont Do

Repair Filter Underdrains 40,000

Assume Replacement -

FORM D S C - 44

| Park | LAME | NATIONAL PARK SERVICE<br>DENVER SERVICE CENTER | | Sheet |
|---|---|---|---|---|
| Area | Colville Bay | | | of |
| Project | Addl improvement | By | Checked | Pkg. |
| Feature | Costs | Date | Date | Account |

CALLVILLE BAY

1 STORAGE TANK CANOPY

N/A

2 COMFORT FACILITIES

Using Class "C" April 1991

400 sf = 100,000 250sf/400 sf (100,000) = 62,500

3 Construction For Lab Separation

Assume Construct 25 ft g 8 ft. high wall

Assume Block Wall

Using 90 Mean pg. 414

200 sf (552/100sf) (Factor 2 mean low)

= 2,208

Painting

Mean pg 228 0.45 sf (2)(200) = 180

2388

Assume 20% Contingencies = 2865 # 2,900

4. Telephone Dialer for Remote Control Alarm 2,500

FORM D S C - 44

| Park | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet |
|---|---|---|---|
| Area | | | of |
| Project Add'l improvement | By | Checked | Pkg. |
| Feature Costs | Date | Date | Account |

CALVILLE BAY - Cont'd.

5 Improvements to Climate Control Equip.

Assume new air conditioning system

800 sf. pg 344 Means Mech.

Means ~~Rooftop~~ Single ~~Zon~~ 4.74/sf

800(4.74)(2-mean Blow) = 7,584

Contingencies @ 20% ≈ 9,100

6 Relocate fill pipe to top of tank

Assume 25' of 6" pipe and valve

Using April 91 Class "C"

25' (@ 22/LF) = 550

Contingencies @ 20% = 660

660

Round to 1,000

FORM D S C - 44

| Park | NATIONAL PARK SERVICE<br>DENVER SERVICE CENTER | | Sheet |
|---|---|---|---|
| Area | | | of |
| Project | By | Checked | Pkg. |
| Feature | Date | Date | Account |

Las Vegas Wash

1. Construct 100,000 gal Storage Tank

Class "C" 100,000 gal = 155,000
Contingencies @ 20% = 186,000 — 186,000

2. Storage Tank Canopy
N/A

3. Improvements to Climate Control Equip
Same as Callville Bay — 9,100

4 Construct Comfort Facilities
Same as Boulder & Callville — 62,500

5. Construction for lab Separation
Same as Callville — 2,900

FORM D S C - 44

| Park | NATIONAL PARK SERVICE DENVER SERVICE CENTER | | Sheet |
|---|---|---|---|
| Area | | | of |
| Project | By | Checked | Pkg. |
| Feature | Date | Date | Account |

Overton Beach

1 Enclosure for Packay Plant

Plant - 20' x 30'

Assume. Enclosure - 35' x 45'

Using Class "C" ux Metal Bldg

@ $35/sf .

$35/sf (35' x 45') = 55,125

Contingencies @ 20% = 66,150 $66,150

2 Storage Tank Canopy

N/A

3 Improvements to Climate Control Equip $9,100

Same as Callville.

FORM D S C - 44

| Park | NATIONAL PARK SERVICE<br>DENVER SERVICE CENTER | | Sheet |
|---|---|---|---|
| Area | | | of |
| Project | By | Checked | Pkg. |
| Feature | Date | Date | Account |

Katherine

1. Comfort Facilities
   Same as other. $ 62,500

2. Construction for lab Separation 2,900

# APPENDIX C

## STATE OF NEVADA NON-COMPLIANCE FINDINGS AT LAKE MEAD WATER TREATMENT FACILITIES

**NATIONAL PARK SERVICE**
**LAKE MEAD PUBLIC WATER SYSTEMS**
**FINDINGS OF 3/4 & 5/91 INSPECTIONS**

1. Currently, the National Park Service (NPS) public water systems are using a polymer (Nalco 8108) as a filter aid without coagulation/flocculation. There is no testing being conducted to optimize the polymer dosage rates, in most cases adequate mixing is not being accomplished and the coagulation/flocculation basins are being bypassed. In order to continue to operate without coagulation/flocculation, the NPS facilities would need to be approved as alternative filtration technology in accordance with Section 31 of the SWTR. Alternatively, these facilities would need to be operated as direct filtration facilities, as defined in the regulation. As a direct filtration facility, ferric chloride or alum would need to be utilized as the primary coagulant in addition to the polymer as a filter aid. Bypassing of the coagulation/flocculation basin would have to be discontinued and it would be required that you demonstrate effective coagulation/flocculation procedures in accordance with Section 40, paragraph 8.

2. The turbidity requirement for surface water systems will be reduced to 0.5 NTU. A monitoring plan must be developed in accordance with Section 34, paragraphs 1 and 2.

3. Monitoring of the disinfection process will need to be initiated in accordance with Section 34, paragraphs 3, 4 and 5. A monitoring plan must be developed for sampling chlorine residual levels and making CT determinations.

4. The new regulations require that 90% of the turbidity measurements following backwashing procedures or interruption events be less than 1.0 NTU, and be less than 0.5 NTU within 4 hours. A sampling tap needs to be available and a monitoring plan developed to test the turbidity of individual filters following backwashing procedures in order to assess compliance with these requirements. If these requirements can not be met, it indicates that backwash procedures are not adequate. Higher backwash rates, installation of surface wash or other improvements may be necessary.

5. Following backwashing procedures or other interruptions in the operation of the filters (on/off cycling), the facilities should filter to waste prior to supplying water into the distribution system. It will be necessary to either expand the backwash lagoons or discharge this water to a sewage facility or other permittable discharge location.

6. At a minimum, an annual inspection of the pressure filters is required to assure that backwashing procedures are adequately cleaning the filter media. This inspection should evaluate the condition of the media, look for the occurrence of mud ball formation and make sure that short circuiting is not occurring.

7. If the NPS facilities are considered direct filtration plants following modifications, they must be operated in accordance with the operating criteria established in Section 40, paragraph 1 and have accurate flow metering capability.

8. While not specifically required by the SWTR, the NPS facilities should be equipped with a self contained breathing apparatus and a chlorine repair kit for each site to assure the safety of the personnel working with chlorine gas. Alternatively, hypochlorination should be considered for these facilities. Also, Uniform Fire Code requirements for compressed gas cylinders have recently been amended and require exhaust systems for treatment of the accidental release of gas from the largest single cylinder of gas stored. We recommend that you consult with the local fire Marshall to determine if the new requirement will apply to the NPS facilities.

9. The SWTR imposes many new requirements for filtration facilities, including that operators must be certified in treatment operations. It should be expected that greater operator efforts will be required at the NPS facilities, and that continuing training will be essential.

10. The SWTR requires that an operations plan be developed for each facility. [The elements to be included are contained in Section 42 of the SWTR]. Many of the concerns raised in this letter must be specifically addressed in this submittal.

# APPENDIX D

## WELL DRILLING COST ESTIMATE FROM CONVERSE CONSULTANTS OF NEVADA

Post-it™ brand fax transmittal memo 7671 | # of pages ▸ 4

| | |
|---|---|
| To TERI DISPAIN | From JIM WERLE |
| Co. NPS/DENVER | Co. CONVERSE |
| Dept. WEST. TEAM/DESIGN | Phone # (702) 795-2121 |
| Fax # (303) 987-6679 | Fax # (702) 798-0098 |

**Converse Consultants Southwest, Inc.**

Geotechnical Engineering and Applied Sciences

September 4, 1992

92-33517-00

Ms. Teri Dispain
National Park Service
Denver Service Center
Western Team/Branch of Design
Denver, CO

Subject: Cost Estimate
Water Well Engineering and Drilling Services
Lake Mead National Recreation Area
Arizona and Nevada

Dear Ms. Dispain,

Converse Consultants Southwest, Inc. (CCSW) has prepared the enclosed cost estimate as requested on August 31, 1992. We contacted several local water well drilling companies to receive an estimated range of costs for each proposed well. We realize that, at this phase of the project, these estimates are preliminary. A number of factors should be considered prior to actually contracting a drilling company to perform the work.

The proposed locations at Lake Mead Recreation Area (LMRA) lack comprehensive hydrological, geological and hydrogeological data. Water wells can represent a large capital investment in a groundwater investigation, therefore each well should be drilled to an optimum design or at the location where it can best fulfill its function. In the case of the LMRA, water quality is also an important issue, even if the well is intended to draw from the nearby lake through groundwater.

To address these issues, a groundwater investigation usually has to be a phased operation designed to build up the necessary information, each successive phase building on the results of the previous ones. In such an investigation the drilling of a water well, if determined feasible through the previous phases, occurs late in the program.

Standard accepted practice for groundwater development programs include the following elements:

1. Site Specific Feasibility Studies
2. Water Quality/Quantity Issues

**Converse Consultants Southwest, Inc.**
4870 South Polaris Avenue
Las Vegas, Nevada 89103-5615
Telephone (702) 795-2121
Facsimile (702) 798-0098

3. Well Siting - Water Quality Sampling
4. Bid Specification Preparation
5. Pilot Hole Drilling, Quality and Quantity Testing
6. Production Well Drilling and Completion
7. Aquifer Testing
8. Well Equipping

It is important to fully study a site from both geologic and hydrologic perspectives so that water quality and quantity goals can be achieved at minimum cost. Acquiring maximum site knowledge allows more detailed preparation of bid specifications. Elimination of unknown conditions prior to drilling will lower drilling costs.

At some locations, exploration and testing for potable groundwater may be more cost effective than immediate drilling. As stated in our Statement of Qualifications, we generally approach each project with Water Quality and Quantity issues in mind so that overall long term costs are reduced. Based on this premise, we have prepared the following conservative cost estimate. More precise cost estimates can be prepared when more data is available for each proposed site.

## ENGINEERING COST ESTIMATE (PER SITE)

| | | |
|---|---|---|
| 1. | Feasibility Study | $2,500 to $5,000 |
| 2. | Water Quality/Quantity | $1,500 to $3,000 |
| 3. | Well Siting<br>Water Quality Analysis | $1,500 to $4,000 |
| | **Total Cost Estimate Range Per Site** | **$5,500 to $12,000** |

If a specific site is determined to be feasible for water well drilling:

## ENGINEERING COST ESTIMATE (PER WELL)

| | | |
|---|---|---|
| 1 | Bid Specification | $1,500 to $3,000 |
| 2. | Pilot Hole Drilling Supervision | $2,000 to $3,000 |
| 3. | Production Well Oversight,<br>Logging, Completion | $5,000 to $6,000 |
| 4. | Aquifer Testing | $3,500 to 6,000 |
| 5. | Well Equipping<br>Design and Inspection | $2,000 to $3,000 |
| | **Total Cost Estimate Range Per Well** | **$14,000 to $21,000** |

## DRILLING BID ESTIMATE (PER WELL)

| | | |
|---|---|---|
| 1. | Mobilization/Demobilization<br>Lump Sum | $3,000 to $6,000 |
| 2. | Boring and Temporary Casing<br>Per Foot | $65 to $95 |
| 3. | Well Casing - 16-inch<br>Per Foot | $20 to $28 |
| 4. | Well Screen - 16-inch<br>Per Foot | $45 to $65 |
| 5. | Well Screen Accessories<br>Lump Sum | $750 to $1,000 |
| 6. | Artificial Filter Pack<br>Per Foot | $10 to $18 |
| 7. | Well Development<br>Per Hour | $180 to $200 |
| 8. | Testing Apparatus<br>Lump Sum | $3,000 to $3,800 |
| 9. | Pumping Test<br>Per Hour | $100 to $175 |
| 10. | Disinfection<br>Lump Sum | $650 to $800 |
| 11. | Annular Grout Seal<br>Per Foot | $30 to $45 |
| 12. | Standby Time | Per Hour |
| **Total Bid Estimate Range Per Well for Drilling** | | **$40,000 to $65,000** |

Each drilling company contacted indicated that costs are variable due to unknown drilling conditions. As we progress with this project, it may be useful to bid each well separately based on site specific conditions. This may yield an overall lower price.

Should you require any additional assistance or have any questions please contact Mr. Dean E. Alford, Senior Staff Hydrogeologist, or the undersigned at your earliest convenience.

Respectfully submitted,

CONVERSE CONSULTANTS SOUTHWEST, INC.

James L. Werle
Principal Geologist

JLW:DEA:glt
52/50G

Encl: Cost Estimates

Dist: 1/Addressee (FAX)

# APPENDIX E

## COST ESTIMATE FOR A PACKAGE PLANT FROM WACCO WATER CONTROL CORP.

WATER CONTROL CORPORATION

2696 South Colorado Blvd., Suite 580 P.O. Box 22001 Denver, Colorado 80222 (303) 757-3522

September 17, 1992

National Park Service
Denver Service Center
12795 West Alameda Pkwy
P.O. Box 25287
Denver, CO 80225

Attn: Ms. Teri D'Spain

Ref: Lake Meade WTP
Las Vegas, NV

Dear Ms. D'Spain:

In accordance with your request for information on a direct filtration water treatment plant capable of handling 225 gpm, we have enclosed herein information on the CPC/Microfloc single compartment gravity filter which will produce 250 gpm at 5 gpm per sq.ft. rate. This unit utilizes the mixed media filter, which Microfloc developed nearly 30 years ago, and which has been so widely accepted for providing quality water at a very economical price.

While we have enclosed information on the single compartment configuration of the GF-50 gravity filter, this unit is also available in a dual compartment configuration, which would provide redundancy if needed. The GF-50 requires a very minimum amount of operator attention, which would primarily consist of mixing any chemicals which were necessary, and visiting the plant for routine inspection on a periodic basis. We estimate the cost for the GF-50-1, complete with static mixer, automatic control valves and control panel, to be approximately $55,000. The only additional items required would be a backwash pump, possibly an influent pump and a surface wash pump, complete with related electrical equipment.

If the water being treated requires a greater degree of treatment, we would recommend that you give serious consideration to the Trident process, which has proven to be one of the most economical complete treatment systems on the market today.

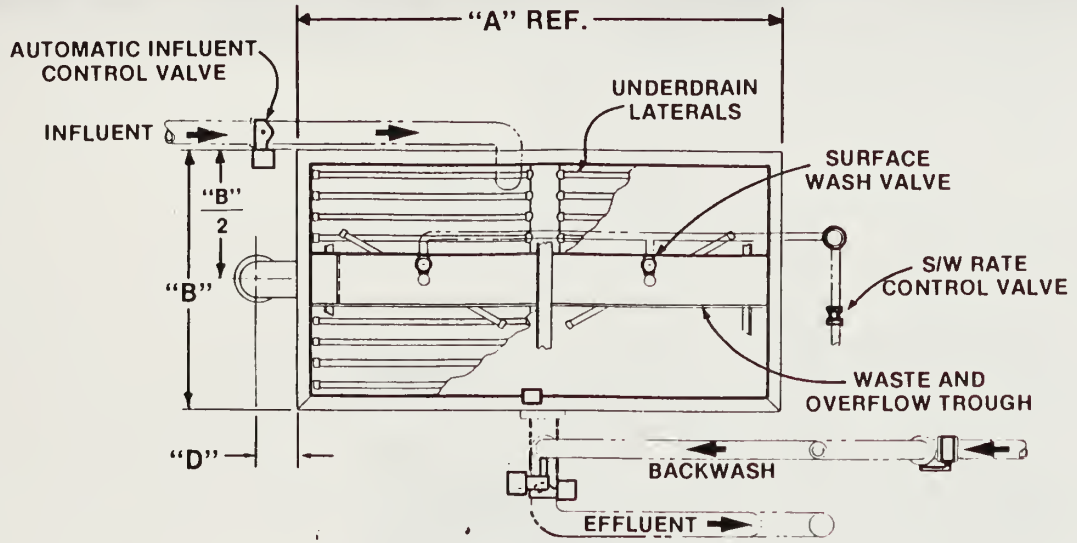
If you have any questions regarding the above, please contact us.

Very truly yours,

WATER CONTROL CORPORATION

Bob Swedberg

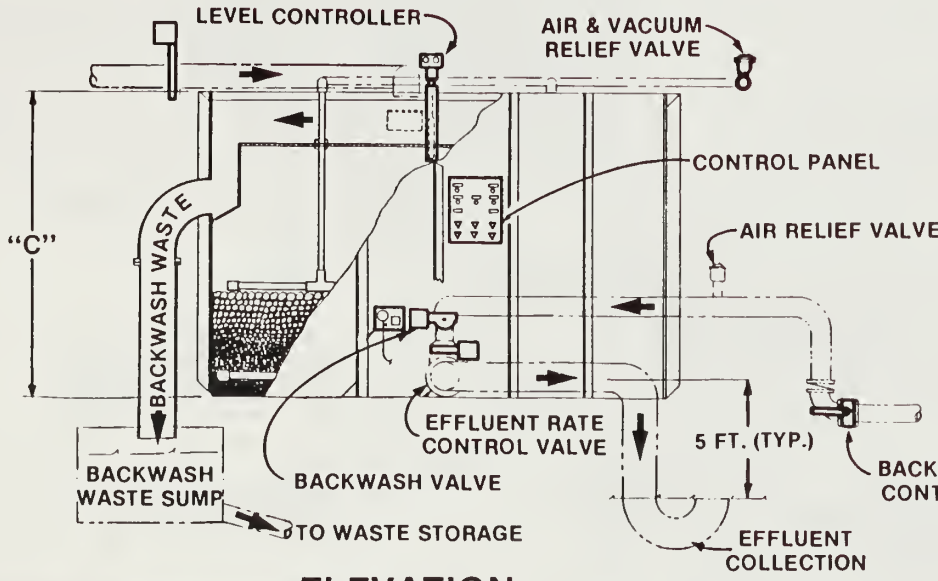
Bob Swedberg



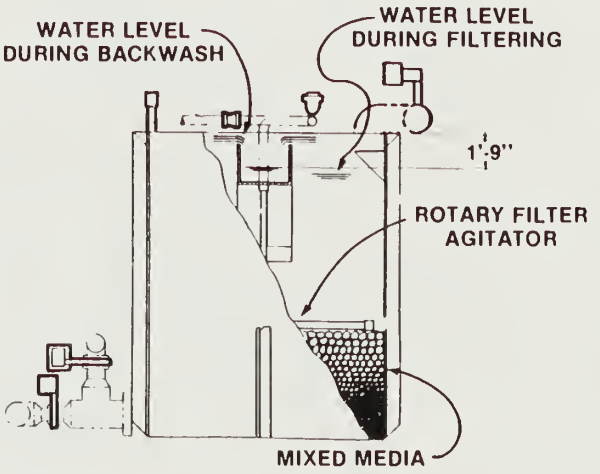

PLAN VIEW

| MODEL | DIMENSIONS "A" | "B" | "C" | "D" |
|---|---|---|---|---|
| GF-20-1 | 5'-6" | 5'-6" | 11'-6" | 0'-6" |
| GF-40-1 | 10' | 5'-6" | 11'-6" | 0'-9" |
| GF-50-1 | 6'-8" | 9'-11" | 11'-6" | 0'-9" |
| GF-80-1 | 19' | 5'-6" | 11'-6" | 1'-0" |
| GF-100-1 | 12'-4" | 9'-11" | 11'-6" | 1'-3" |
| GF-150-1 | 18' | 9'-11" | 11'-6" | 1'-6" |
| GF-200-1 | 23'-6" | 9'-11" | 11'-6" | 1'-9" |

NOTE: PHANTOM LINE INDICATES PIPING AND EQUIPMENT BY OTHERS.




ELEVATION




END VIEW

Neptune Microfloc, Inc.
P.O. Box 612
Corvallis, OR 97339
(503) 754-7654

This drawing and information contained thereon is the property of Neptune Microfloc Incorporated and must not be used in any way detrimental to the interest of the corporation. This drawing must be returned at the request of Neptune Microfloc Incorporated

SCALE

NOTE
DO NOT SCALE FROM THIS DRAWING TO OBTAIN DIMENSIONS

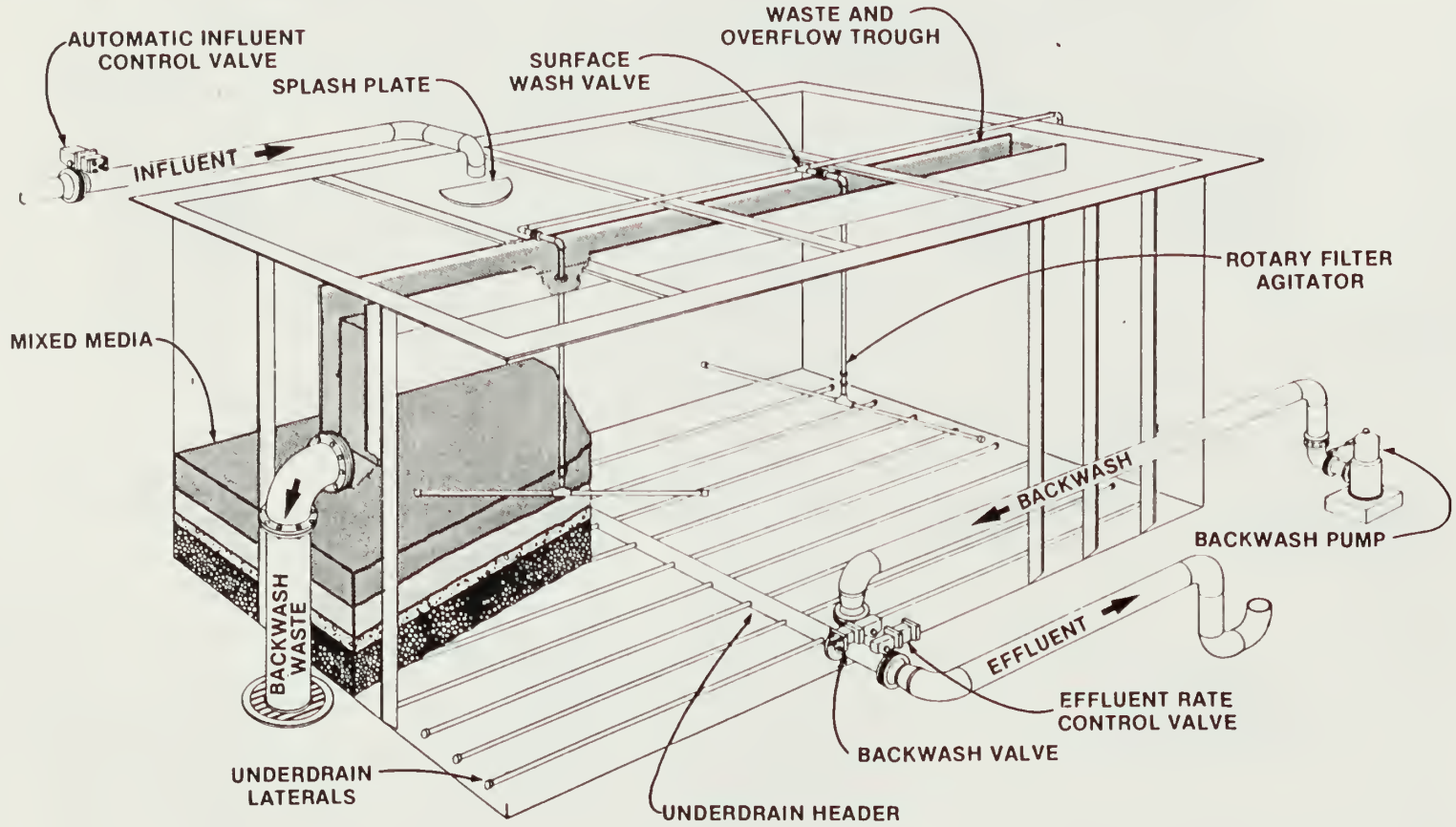
neptune microfloc
A WHEELABRATOR-FRYE COMPANY

| | |
|---|---|
| DRAWN | DATE 10/81 |
| COORDINATOR | DATE |
| CHECKED | DATE |
| APPROVED | DATE |

# ARRANGEMENT
# SINGLE COMPARTMENT GRAVITY FILTER

DRAWING NO. M 2120 REV

SHEET OF

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# PICTORIAL
## SINGLE COMPARTMENT GRAVITY FILTER

DRAWING NO: KS 6.78-1
REV:
SHEET: OF

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# REFERENCE NOTES

1 Arrangement shown is for pumped influent and constant rate gravity flow to a below grade finished water storage. Equipment, piping and valves may be rearranged to meet job site requirements.

2 Effluent nozzles provide for connection to customers pipe spool with victualic coupling or flanges.

3 **Control Scheme** for **single** chamber filter:

An automatic influent valve is provided to set and control plant flow. Valve is closed, and flow is shut off during backwash cycle.

4 Waste trough is positioned above the normal operating water level, and carries backwash waste to discharge without need for waste valves. Trough also carries flow to discharge in case of overflow condition.

5 Liquid level controllers operate effluent valves to maintain constant filter level, and include switches for low level media protection.

6 Control circuits provide for automatic backwash and return to service by programmed time clock sequence with vacuum switch override in case of high filter headloss or manual switch initiation.

7 Terminal contacts are provided in the plant controller for connection of the following external level control switches if required.

a. One (1) level switch in finished water storage tank.

b. Two (2) level switches in backwash/surface wash supply tank. (If separate from finished water storage)

c. Two (2) level switches in backwash waste storage tank.

8 Check valves are required in backwash and surface wash lines. (By others)

# GENERAL NOTES

1 Standard unit does not include the following equipment. However, Neptune Microfloc will quote and supply any of the various components upon request.

a. Pipe spools, piping and pipe supports.
b. Pumps and associated check valves.
c. Connection fittings.
d. Wiring, conduit and load center.
e. Air compressor and air piping.
f. Level switches for external system storage tanks where used.

2 Major equipment and components to be assembled at jobsite, by others.

3 Tanks should be level within 1/8 inch at time of installation. Base pad design and installation by others.

4 Backwash waste and overflow sump must be sized to handle maximum anticipated discharge flow for particular model. (See technical data sheet.)

5 Piping connections from filter tank drain to floor drain is recommended.

6 Available options include:

a. Polymer, alum, soda ash and other chemical feed systems.
b. Effluent turbidity monitoring package including turbidimeter, recorders and interconnecting controls.
c. Raw water turbidity monitoring.
d. For other options, consult factory.

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# SINGLE COMPARTMENT GRAVITY FILTERS
# TECHNICAL DATA SHEET

| TECHNICAL DATA/MODEL | | GF-20-1 | GF-40-1 | GF-50-1 | GF-80-1 | GF-100-1 | GF-150-1 | GF-200-1 |
|---|---|---|---|---|---|---|---|---|
| Filter Specs | Filter Area | 20 ft² | 40 ft² | 50 ft² | 80 ft² | 100 ft² | 150 ft² | 200 ft² |
| | Flow Range (gpm) | 100-160 | 200-320 | 250-400 | 400-640 | 500-800 | 750-1200 | 1000-1800 |
| Tank Dimensions | Length | 5 ft. 6 in. | 10 ft. | 6 ft. 8 in. | 19 ft. | 12 ft. 4 in. | 18 ft. | 23 ft. 6 in. |
| | Width | 5 ft.-6 in. | 5 ft.-6 in. | 9 ft.-11 in. | 5 ft.-6 in. | 9 ft.-11 in. | 9 ft.-11 in. | 9 ft.-11 in. |
| | Height | 11 ft.-6 in. | 11 ft.-6 in. | 11 ft.-6 in. | 11 ft.-6 in. | 11 ft.-6 in. | 11 ft.-6 in. | 11 ft.-6 in. |
| Weights | Tank | 4,500 lbs. | 6,500 lbs. | 9,000 lbs. | 13,000 lbs. | 13,000 lbs. | 17,000 lbs. | 22,000 lbs. |
| | Shipping | 13,200 lbs. | 22,900 lbs. | 30,200 lbs. | 45,800 lbs. | 54,400 lbs. | 77,600 lbs. | 102,800 lbs. |
| | Operating | 24,000 lbs. | 45,000 lbs. | 56,000 lbs. | 90,000 lbs. | 106,000 lbs. | 157,000 lbs. | 207,000 lbs. |
| Pipe Connections (All Piping by Others) | Influent | 3 in. | 4 in. | 4 in. | 4 in. | 6 in. | 6 in. | 8 in. |
| | Effluent | 3 in. | 4 in. | 6 in. | 6 in. | 6 in. | 10 in. | 10 in. |
| | Backwash | 4 in. | 6 in. | 8 in. | 8 in. | 10 in. | 14 in. | 14 in. |
| | Waste & O/F | 8 in. | 10 in. | 10 in. | 12 in. | 14 in. | 16 in. | 18 in. |
| | Surface Wash | 2 in. | 2 in. | 2 in. | 2 in. | 3 in. | 3 in. | 3 in. |

Notes:

Flow range is based on filtration rate of 5-8 gpm/ft². The appropriate filter rate for each application is a function of such variables as media design, available head, desired filter run length and water quality. Consult Neptune Microfloc or its representative for optimization of flow rate and filter media design.

To obtain maximum filter run, discharge effluent a minimum of 5 feet below tank effluent nozzle.

Typical filter backwash rate is 15-20 gpm/ft² for 6-8 minutes. Backwash storage should be sized for a minimum of two backwashes.

Standard tank finish is bare interior and prime painted exterior. Tank bottom is bare for placement in coal tar or asphaltic mastic compound. Alternate finishes are available.

A minimum of 4 feet overhead clearance is required for service and maintenance.

Filters are designed for indoor installation.

Electrical requirements are 3 wire, 15 amp, 115 V, 1 Ø, 60 Hz. Dry filtered air requirements are 6.5 scfm at 80 psig.

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KS 6.78-1

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his specification describes the following gravity filter standard odels:

he following seven filter models are n individual tanks.

| Model | $Ft^2$ | Dwg | Tech. Data |
|---|---|---|---|
| F-200-1 | 200 | | |
| F-150-1 | 150 | | |
| F-100-1 | 100 | | |
| F- 80-1 | 80 | M2120 | KS 6.78-1 |
| F- 50-1 | 50 | | |
| F- 40-1 | 40 | | |
| F- 20-1 | 20 | | |

ilter area in the following six models s divided equally into two individual ompartments in one common tank.

| | | | |
|---|---|---|---|
| F-300-2 | 300 | | |
| F-200-2 | 200 | | |
| F-150-2 | 150 | M2121 | KS 6.78-2 |
| 100-2 | 100 | | |
| F- 80-2 | 80 | | |
| F- 40 2 | 40 | | |

ilter area in the following five odels is divided equally into four ndividual compartments in one common ank.

| | | | |
|---|---|---|---|
| F-500-4 | 500 | | |
| F-400-4 | 400 | | |
| F-300-4 | 300 | M2122 | KS 6.78-4 |
| F-200-4 | 200 | | |
| F- 80-4 | 80 | | |

election of gravity filters is de- ailed in Application Data KS 6.71.

he following drawings for the three tyles of gravity filters listed above re available to aid in selection:

our Filter Style:

| | |
|---|---|
| low Schematic | FOF-3 |
| trical | FOE-6 |
| erconnection | FOE-5 |

## SECTION 1.0 GENERAL

### 1.1 DESCRIPTION

Under this section of the specification, the contractor shall furnish and install a factory-built modular filtration plant consisting of a rectangular tank(s) containing a Mixed Media filter bed(s) with necessary flow and filtering controls. The tank(s) shall be factory finished and shall be installed without field welding. The plant shall be similar and equal to Gravity Filter Model GF-__ - __ manufactured by NEPTUNE MICROFLOC, INC., 1965 Airport Rd., Corvallis, OR 97333.

All equipment specified in this section shall be provided by one supplier to ensure a properly designed system. The filtration package plant shall be capable of the following process characteristics:

| | |
|---|---|
| Design flow rate: | _____ gpm |
| Maximum flow rate: | _____ gpm |
| Filtration rate at design flow: | _____ gpm/sq.ft. |
| Influent solids: | _____ TU (mg/L) |
| Effluent solids: | _____ TU (mg/L) |

The contractor shall pay all royalty or license fees for use of patented devices or systems and shall protect the owner from patent infringement litigation thereon.

Suppliers other than the above named company wishing to quote on materials and equipment in this section shall submit suitable evidence of experience and results with the concepts contained herein to the engineer and obtain his written approval to quote at least 10 days prior to bid opening.

### 1.2 PROCESS

Filtration shall be accomplished with a filter bed consisting of filter materials of sizes and specific gravities that automatically intermix during backwashing to create solids collection voids in the filter of decreasing size in the direction of flow.

The filter(s) shall be self-contained in a rectangular steel tank equipped with flow distribution control equipment and underdrain system which provides for uniform collection of filtered water and distribution of backwash flow.

Two Filter Style:

| | |
|---|---|
| Flow Schematic | FOF-2 |
| Electrical | FOE-4 |
| Interconnection | FOE-3 |

Single Filter Style:

| | |
|---|---|
| Flow Schematic | FOF-2 |
| Electrical | FOE-2 |
| Interconnection | FOE-1 |

Filter Design Drawing, FOA-4, applies to all models.

NMI gravity filter plants offer a proven, efficient approach to water treatment for the removal of suspended solids, algae, organic matter, iron and manganese, and other precipitates through chemical treatment of ground or surface water or wastewater which are to be used for municipal, industrial or recreational purposes.

Gravity filter plants are provided for use with below-grade receiving reservoirs. Minimum elevations are shown on arrangement drawings. Effluent pumping to above grade reservoirs is also available.

Interior tank surfaces can be coated and exterior finish paint can be furnished as options.

Contact Neptune Microfloc, Inc., or its representative for the most suitable Mixed Media filter bed design for a particular application.

A water sample can be examined in the NMI laboratory to aid in determining the most effective bed design.

Highly efficient Mixed Media filter beds operate at a nominal filter rate of 5-8 gpm/sq.ft. of filter area.

Mixed Media filter beds are processed on-site under the direction of a highly trained Neptune Microfloc technician to assure optimum performance.

Filter level shall be maintained by a liquid level controller in the filter and control valve which automatically adjusts as solids accumulate in the filter.

Filter backwashing shall be controlled by a programmable time clock with automatic initiation by filter headloss.

1.3 PLANT EQUIPMENT

The filtration plant shall be designed for indoor, above-grade installation.

The tank(s), filter materials, equipment and controls shall be provided by the plant manufacturer for installation and assembly at the jobsite. Installation and piping shall be provided by others according to the plans. Field welding shall not be required.

Tanks shall be fabricated from structural grade steel in strict accordance with the equipment supplier's instructions and specifications. All workmanship shall conform to industry and the manufacturer's standards. Standard factory finish shall be bare interior and prime painted exterior in accordance with the filtration plant manufacturer's specifications.

SECTION 2.0 MIXED MEDIA FILTER

Filter materials shall be furnished for each filter to provide a Mixed Media bed of a total depth not less than _____ inches composed of three or more materials, each of a different size and specific gravity. The size gradation and specific gravity of the filter bed materials shall be prescribed by the filtration plant manufacturer so that the materials intermix to provide a uniform void distribution from coarse to fine in the direction of flow through the filter. The top of the bed shall consist of material of approximately 1.2 mm particle size and the bottom of approximately 0.3 mm size.

The total filter area shall be ____ sq.ft. and the finished filter bed shall be equal to NEPTUNE MICROFLOC, INC., type MF ____.

Filter supporting gravel designed for the underdrain system shall be provided by the manufacturer. The support gravel shall include a 3 inch stabilizing layer of 1-2 mm specific gravity ± 4.0 high density gravel to stabilize the gravel/media interface and minimize possibility of silica gravel shifting.

All materials shall be furnished by the filtration plant manufacturer and shall be shipped in bags for installation by the contractor.

Placement and on-site processing of the filter and support bed to achieve the required gradation shall be accomplished under the technical direction of the manufacturer's representative.

## SECTION 3.0 GRAVITY FILTER TANKS

The filtration plant shall include ____ open top gravity filter tank(s) _____ wide x _____ long x _____ high with _____ filter chamber(s). Minimum plate thickness shall be 1/4 inch steel. The tank(s) shall be fitted with lifting lugs for handling and placement and shall include the following:

elete for single compartment style. A atching device is available which llows the flap valves to be used for ilter isolation.

Influent Trough. Each tank shall be provided with a trough of a size and shape so as to distribute the influent flow equally amongst the filter chambers. The trough shall be equipped with flap type valves which shall close automatically to prevent backflow into the trough during backwashing of any filter and distribute the flow to the filter(s) remaining on-line.

aste collection sump shall have a free low capacity equal to the total of the nfluent flow, the backwash flow and he surface wash flow.

Waste and Overflow Trough. Each tank shall be provided with a trough into which flow is directed during backwashing resulting in uniform collection of solids washed out of the filter. The flow in the trough shall be directed to an outlet to a waste collection sump without interference with filters still on-line. The trough and outlet shall be capable of conducting all flow into the tank to the waste collection sump without overflowing the tank should an equipment failure occur. The waste collection sump shall be provided by others.

urface wash is furnished to improve ackwash efficiency and overall performance.

Rotary Filter Agitators. Straight type rotary agitators shall be provided which direct water jets into the upper layers of the filter bed to aid in washing accumulated solids out to waste during backwashing. The filter bed agitators shall be of bronze construction, revolving self-propelling type. Electric current corrosion shall be prevented by dielectric couplings provided between the agitators and the supply piping. Agitators shall be shipped loose for field installation.

Underdrain. Each filter chamber shall be equipped with an underdrain manifold of adequate size for uniform distribution of backwash flow and shall have screwed

Delete if backwash waste is returned to the head of the plant or discharged to a holding pond.

backwash waste tank--one set of contracts shall close when there is sufficient volume in the tank to receive the complete backwash volume, allowing initiation of a backwash cycle; second, safety contacts shall open and abort a backwash cycle at a level to prevent overflow.

Terminals shall be provided in the plant controller for connection to the switch devices.

Effluent turbidity monitoring assures proper plant performance and is available as an option. Indicating or recording equipment can be provided with the indicator or recorder custom mounted in the plant control panel.

The filtration plant manufacturer shall furnish the following control devices and equipment for installation by the contractor on each filter:

backwash initiate vacuum switch with indicating gage assembled on a mounting panel;

pneumatic liquid level controller to control filter effluent valve;

Plant will automatically shut down and sound an alarm when effluent turbidity exceeds a preset level if required.

level switch for media protection (mounted in the level controller.

## SECTION 7.0 ELECTRICAL REQUIREMENTS

The plant controller shall be provided with a 115 volt, 60 hertz, single phase power, 15 amp circuit. All electrical connections between equipment shall be provided and installed by the contractor.

## SECTION 8.0 PNEUMATIC REQUIREMENTS

The contractor shall furnish and install an air supply system capable of providing clean, oil free, dry air at _____ scfm at 80 psig without excessive cycling.

## SECTION 9.0 PLANT STARTUP AND OPERATOR TRAINING

On-site review of equipment operation and operator retraining are suggested at 6 months and 1 year after startup.

The filtration plant manufacturer shall provide for _____ days of plant startup and operator training and shall include direction for the placement of the filter media, plant checkout, and operator instruction.

## SECTION 10.0 DOCUMENTS

The filtration plant manufacturer shall furnish _____ Owners Manuals which shall provide complete instructions for installation, startup, operation, and maintenance.

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.